

**DROUGHT FORECASTING, MONITORING AND
DECISION-MAKING: A REVIEW OF THE NATIONAL
INTEGRATED DROUGHT INFORMATION SYSTEM**

HEARING
BEFORE THE
**COMMITTEE ON SCIENCE, SPACE, AND
TECHNOLOGY**
HOUSE OF REPRESENTATIVES
ONE HUNDRED TWELFTH CONGRESS

SECOND SESSION

WEDNESDAY, JULY 25, 2012

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A REVIEW OF THE NATIONAL
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SYSTEM**

WEDNESDAY, JULY 25, 2012

HOUSE OF REPRESENTATIVES,
COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY,
Washington, D.C.

The Committee met, pursuant to call, at 10:02 a.m., in Room 2318 of the Rayburn House Office Building, Hon. Ralph M. Hall [Chairman of the Committee] presiding.

RALPH M. HALL, TEXAS
CHAIRMAN

EDDIE BERNICE JOHNSON, TEXAS
RANKING MEMBER

U.S. HOUSE OF REPRESENTATIVES
COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY

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***Drought Forecasting, Monitoring, and Decision-Making: A Review of the
National Integrated Drought Information System***

Wednesday, July 25, 2012
10:00 a.m.-12:00 p.m.
2318 Rayburn House Office Building

Witnesses

Dr. Roger S. Pulwarty, Director, National Integrated Drought Information System, National
Oceanic and Atmospheric Administration (NOAA)

The Honorable Gregory A. Ballard, Mayor, City of Indianapolis

Mr. J.D. Strong, Executive Director, Oklahoma Water Resources Board

Dr. James S. Famiglietti, Professor and Director, Earth System Science, University of
California, Irvine

Ms. Patricia Langenfelder, President, Maryland Farm Bureau

**COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
U.S. HOUSE OF REPRESENTATIVES**

HEARING CHARTER

*Drought Forecasting, Monitoring, and Decision-Making: A Review of the National
Integrated Drought Information System*

Wednesday, July 25th, 2012
10:00 a.m. to 12:00 p.m.
2318 Rayburn House Office Building

PURPOSE

On Wednesday, July 25th, 2012, the Committee on Science, Space, and Technology will hold a legislative hearing to examine the state of drought forecasting, monitoring, and decision-making and the role the National Integrated Drought Information System (NIDIS) serves in drought planning. Additionally, the Committee will receive testimony on draft legislation entitled, "The National Integrated Drought Information System Reauthorization Act of 2012." Witnesses have been asked to provide comments on, and suggestions to, this discussion draft.

WITNESSES

Dr. Roger S. Pulwarty, Director, National Integrated Drought Information System, National Oceanic and Atmospheric Administration (NOAA)

The Honorable Gregory A. Ballard, Mayor, City of Indianapolis

Mr. J.D. Strong, Executive Director, Oklahoma Water Resources Board

Dr. James S. Famiglietti, Professor and Director, Earth System Science, University of California, Irvine

Ms. Patricia Langenfelder, President, Maryland Farm Bureau

Background

The definition of drought, the conditions that lead to a drought, and the defining features of a drought can vary depending on geographic location or region; characteristics of a drought in one region may be different from those elsewhere. However, drought can be loosely defined as the absence of water and further identified as a "condition of moisture deficit to have an adverse

effect on vegetation, animals, and man over a sizeable area.”¹ Droughts are generally associated with periods of dry weather characterized by a shortage of precipitation (meteorological droughts). These conditions can cause hydrologic imbalances and lead to below average water levels in streams, reservoirs, and groundwater aquifers (hydrological droughts), and can adversely affect agriculture and livestock operations (agricultural droughts), negatively impact flora and fauna, and also strain water resources for affected municipalities and communities. The severity of droughts depends upon many factors, including the degree of moisture deficiency, duration of the conditions, and the size of the affected area. The variability of the definition, and the conditions that cause droughts, presents unique challenges in identifying the onset, severity, and duration of a drought. As no single operational definition works in all circumstances, planning for and recognizing droughts can be difficult².

Classifying Drought

Drought has afflicted portions of North America for thousands of years. Severe, long-lasting droughts may have been a factor in the disintegration of Pueblo society in the Southwest during the 13th century, and in the demise of central and lower Mississippi Valley societies in the 14th through 16th centuries. In the 20th century, droughts in the 1930s (Dust Bowl era) and 1950s were particularly severe and widespread. In 1934, 65% of the contiguous United States was affected by severe to extreme drought.³

The US Drought Monitor (see Figure 1 below) provides a summary of drought conditions across the country by combining a variety of drought indices and indicators into a single composite drought indicator, updated weekly⁴. The map classifies drought conditions based on four levels of intensity ranging from moderate to exceptional, similar to the scale used to communicate the intensity of tornados and hurricanes, and also includes a classification for conditions of abnormal dryness⁵. The map also identifies areas that are in a short or long term drought, based on whether they are hydrological or agricultural, respectively.

According to the July 17, 2012 US Drought Monitor data, over seventy percent of the country is currently classified as abnormally dry or worse. Additionally, over half of the continental US is experiencing moderate to extreme drought, and a third of the country is characterized as being in severe to extreme drought⁶ as determined by the Palmer Drought Severity Index⁷. This index classifies meteorological drought in terms of supply and demand of water by balancing needs versus precipitation.

¹ USGS Definitions of Drought, Accessible at: <http://md.water.usgs.gov/drought/define.html>.

² National Drought Mitigation Center, University of Nebraska, Lincoln. What is a Drought? Accessible at: <http://drought.unl.edu/DroughtBasics/WhatIsDrought.aspx>.

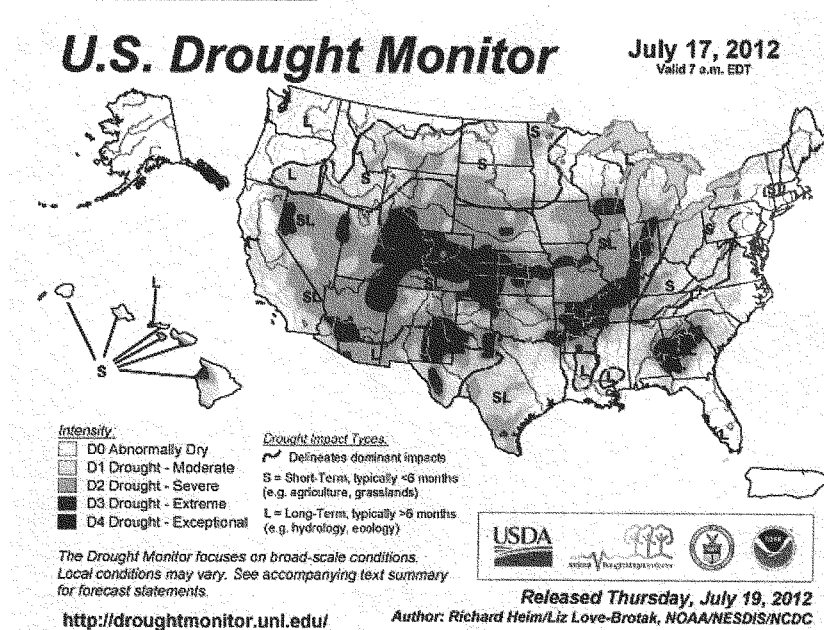
³ Congressional Research Service. *Drought in the United States: Causes and Issues for Congress*. RL34580. June 12, 2012.

⁴ The US Drought Monitor was unveiled in August 1999 at a White House press conference, and was the culmination of experts' recognition of the need for a simple and accurate way to communicate drought conditions to decision makers and the public. Accessible at: <http://droughtmonitor.unl.edu/>.

⁵ D0=Abnormally Dry; D1=Moderate; D2=Severe; D3=Severe; D4=Exceptional

⁶ Data accessible at http://droughtmonitor.unl.edu/DM_tables.htm?conus.

⁷ http://www.drought.gov/portal/server.pt/gateway/PTARGS_0_2_693_208_0_43/http%3B/drought.unl.edu/Planning/Monitoring/ComparisonofIndicesIntro/PDSI.aspx

Figure 1. U.S. Drought Monitor⁸

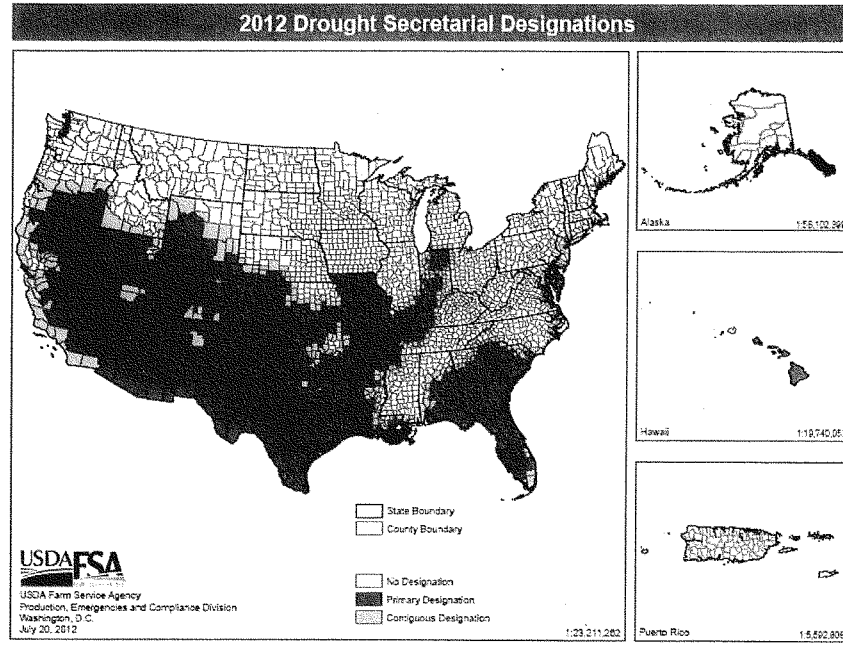
According to the Department of Agriculture (USDA), the current widespread drought conditions are having an impact on the Nation's corn and soybean crops; as of July 17, 2012, 88 percent of the country's corn and 87 percent of the country's soybeans are in drought-stricken areas⁹. As shown in Figure 2, Secretary of Agriculture Tom Vilsack has designated 1,055 counties across the country as disaster areas¹⁰ due to drought conditions. A drought disaster is declared if 30 percent of the commodities in the county have been damaged due to drought conditions. On July 11, 2012, USDA streamlined its rules for disaster determinations, declaring that any county experiencing D2 (see intensity scale in Figure 1) or greater for eight weeks shall be granted a disaster designation.¹¹

⁸ NIDIS Drought Portal, U.S. Drought Monitor. Accessible at www.drought.gov.

⁹ Weekly Column: The Means to Help Producers Impacted by Drought, July 20, 2012. Accessible at <http://content.govdelivery.com/bulletins/gd/USDAOC-4a7395>.

¹⁰ *Ibid.*

¹¹ Brown, Tanya. USDA Farm Services Administration Fence Post, *New Designation Process Fast-Tracks Thousands of Counties into Disaster Status*, July 11, 2012. Accessible at: <http://fsa.blogs.govdelivery.com/2012/07/11/new-designation-process-fast-tracks-thousands-of-counties-into-disaster-status/>.

Figure 2. USDA Secretarial Disaster Designations Map¹²

History of the National Integrated Drought Information System

In 1998, Congress passed the National Drought Policy Act¹³, establishing the National Drought Policy Commission to provide advice and recommendations on the creation of an integrated, coordinated Federal policy designed to prepare for, and respond to, serious drought emergencies. The Commission submitted the report, *Preparing for Drought in the 21st Century*, to Congress in 2000.¹⁴ The recommendations in this report included a policy shift from drought relief to drought preparedness, and urged coordination in delivering federal drought-related services and data. The report called for improved collaboration to enhance the effectiveness of observation networks, monitoring, prediction, information delivery, and applied research and specifically advocated a comprehensive information gateway for drought-related data. This report inspired the Western

¹² Accessible at http://www.fsa.usda.gov/Internet/FSA_File/drought_secretarial_desig_12.pdf.

¹³ Public Law 105-199; 105th Congress, H.R. 3035, National Drought Policy Act. Accessible at: <http://www.gpo.gov/fdsys/pkg/BILLS-105hr3035enr/pdf/BILLS-105hr3035enr.pdf>.

¹⁴ Report of the National Drought Policy Commission. *Preparing for Drought in the 21st Century*. Accessible at: <http://govinfo.library.unt.edu/drought/finalreport/fullreport/pdf/reportfull.pdf>.

Governors Association 2004 report, “Creating a Drought Early Warning System for the 21st Century,” which conceptualized the NIDIS program.¹⁵

These reports ultimately led to H.R. 5136¹⁶, the National Integrated Drought Information Act of 2006, introduced by Congressmen Ralph Hall and Mark Udall in April of 2006 and subsequently referred to the Committee on Science. On May 4, 2006, the Environment, Technology and Standards Subcommittee held a legislative hearing on the proposed bill and the state of drought forecasting, drought information needs. The bill was later considered by the full Committee on June 7, 2006 and passed both the House and the Senate unanimously on September 26, 2006 and on December 6, 2006, respectively. On December 20, 2006, President George W. Bush signed the bill into law (Public Law 109-460).

The NIDIS Act defined drought as “a deficiency in precipitation that leads to a deficiency in surface or subsurface water supplies and causes or may cause substantial economic or social impacts or substantial physical damage or injury to individuals, property, or the environment.” The law established a NIDIS program (the “Program”) at the National Oceanic and Atmospheric Administration (NOAA), and tasked the Program with providing an effective early warning system, coordinating and integrating Federal research in support of the early warning system, and building upon existing forecasting and assessment programs and partnerships. NOAA was also required by the law to consult with relevant Federal, regional, State, tribal, and local government agencies, research institutions, and the private sector in developing the Program.

Implementation

The Program is housed in the Climate Program Office within the Office of Oceanic and Atmospheric Research at NOAA. The goal of NIDIS is to “improve the nation’s capacity to proactively manage drought-related risks, by providing those affected with the best available information and tools to assess the potential impacts of drought, and to better prepare for and mitigate the effects of drought.”¹⁷ In support of these goals, NOAA conducted workshops with federal, state, and local agencies, academic researchers, and other stakeholders to solicit input on how to develop a path forward. This culminated in the 2007 NIDIS Implementation Plan, which outlined the governance structure, priorities, and operational requirements needed to meet the Program’s objectives. These objectives were identified as:¹⁸

- Develop the leadership and partnerships to ensure successful implementation of an integrated national drought monitoring system at federal, state, and local levels
- Foster and support a research environment that focuses on risk assessment, forecasting, and management

¹⁵ Western Governors Association, *Creating a Drought Early Warning System for the 21st Century: The National Integrated Drought Information Act*, June 2004. Accessible at: <http://www.westgov.org/wga/publicat/nidis.pdf>.

¹⁶ Public Law 109-430; 109th Congress, H.R. 5136, The National Integrated Drought Information Act of 2006. Accessible at: <http://www.gpo.gov/fdsys/pkg/PLAW-109publ430/pdf/PLAW-109publ430.pdf>.

¹⁷ The National Integrated Drought Information System Implementation Plan: A Pathway for National Resilience,” June 2007. Accessible at: <http://www.drought.gov/pdf/NIDIS-IPFinal-June07.pdf>.

¹⁸ Ibid.

- Create a drought early warning system capable of providing accurate, timely, and integrated information on drought conditions and associated risks at relevant spatial scales to facilitate proactive decisions
- Provide interactive delivery systems, including an internet portal, as part of the early warning information system, for easily comprehensible and standardized products; and
- Provide a framework for increasing public awareness and educating those affected by drought on how and why droughts occur, and how they impact human and natural systems.

The implementation plan also included a list of program milestones that reflect key objectives in support of the Program, and projected dates for meeting these objectives.

Table 1. NIDIS Implementation Milestones (FY 2007-2012, by year)¹⁹

Activity	Milestone	07	08	09	10	11	12	13
1	Initial portal operational capability at drought.gov							
1	Advanced portal mapping capability with OIS tools							
1	Populate drought.gov website (portal, plans, reports, agency links)							
1	Operational portal communities and collaborations							
1	Enhance data management and distribution							
1	Portal extension to hemispheric and global domains							
2	Drought forecast regionalization studies							
2	Enhance soil moisture and temperature measurements							
2	Forecast verification and calibration to measurements							
3	Coordinate with CPO Program Managers/agencies on interdisciplinary research goals							
3	Inventory drought-related service (federal/state/private)							
3	Assess national status of drought early warning							
3	Inventory drought-related research (federal/state/private)							
3	Coordinate drought preparedness plans							
3	Planning for adaptation							
3	Institutionalize "Drought Coordinator" network							
3	Enhanced regional impacts research							
3	Implement adaptive management strategies							
4	Pilot study scoping and selection							
4	NPIT workshops: Define criteria and assess partner interest and capacity for pilots							
4	First Workshop: Assessment of Drought Early Warning System Status in the United States							
4	Pilot study implementation							
4	Initial early warning prototypes							
4	Pilot study assessment and follow-on work							
5	Establish NIDIS Program Office, governance structure, and final Program Implementation Team							
5	Establish regional sub-team leads within NPIT							
5	Establish initial agency/state rotational assignment to NIDIS Program							
5	Establish NIDIS Interdisciplinary Research Coordination Board							
5	Extend NIDIS to National Governors' Association and Inter-basin Watershed Commission							
5	Operational workshops to assess national drought monitoring and forecasting gaps							

Current Activity

In support of the overall program goals, the NIDIS Program is engaged in the collection, consolidation, and dissemination of drought-related data and information on an ongoing basis. The Program develops "a suite of usable drought decision support tools focused on critical management indicators, thresholds and triggers, and engages and enables proactive planning by

¹⁹ *Ibid.*

those affected by drought...” as part of their mission²⁰. In this function, NIDIS acts as a data clearinghouse, and also works to develop and actively support a collaborative framework between researchers and managers. The Program also conducts knowledge assessments to “determine where major drought-information gaps occur and where research improvements are needed” as well as to “coordinate capabilities among those conducting research and research activities.”²¹

The NIDIS Program developed and currently operates the U.S. Drought Portal, a website that features a range of services related to drought, including historical data on past droughts, current data from climate observations, early warnings about emerging and potential droughts, decision support services for managing droughts, and a forum for stakeholders to discuss drought-related issues.²² Further, the Program developed and operates four regional drought early warning system pilot projects, which encompass the upper Colorado basin, California, the Four Corners Region of the Southwest, and the Apalachicola-Chattahoochee-Flint River Basin in the Southeast. A scoping workshop has also been scheduled for July 31-August 1, 2012 to discuss a drought early warning system pilot project for the Carolinas that will focus on coastal ecosystems.²³

In its FY 2013 budget request²⁴, NOAA requested \$13.6 million for NIDIS, a \$1.5 million increase and 0 FTEs above the FY2012 level. This increase would focus on development of additional Regional Drought Early Warning Information Systems and enable NIDIS to extend products, tools, and knowledge to areas outside of the NIDIS Pilot areas.

Table 2. NIDIS Funding, FY 2007-2012

Fiscal Year	Authorized Amount	Amount in NOAA Spend Plan
2007	\$11.0 million	\$4.0 million
2008	\$12.0 million	\$8.4 million
2009	\$13.0 million	\$10.4 million
2010	\$14.0 million	\$12.9 million
2011	\$15.0 million	\$13.7 million
2012	\$16.0 million	\$12.2 million
Total, FY 2007-2012	\$81.0 million	\$61.5 million

²⁰ Pulwarty, Roger, Fall 2011 NIDIS Drought Research Special Issue, “Coping with Drought: Research in Support of NIDIS” Volume 2, Issue 2. Accessible at:

http://drought.gov/imageserver/NIDIS/newsletter/Fall_2011_Research_Special_Issue.pdf

²¹ Ibid.

²² NOAA Climate Program Office, National Integrated Drought Information System. Accessible at:

http://www.cpo.noaa.gov/cpo_pa/nidis/pdf/NIDIS_Feb17.pdf

²³ Project Announcement, NIDIS Pilot Project in the Carolinas. Accessible at:

http://www.drought.gov/imageserver/NIDIS/workshops/carolinas_drought_early_warning_scoping_workshop_2012/docs/NIDIS-Carolinas_Pilot_Project_Announcement.pdf

²⁴ NOAA FY 2013 Budget Request Summary. Accessible at:

http://www.corporateservices.noaa.gov/nbo/fy13_bluebook/noaaBlueBook_2013_Web_Full.pdf

Discussion Draft: National Integrated Drought Information System Reauthorization Act of 2012

Section-by-Section Analysis

Purpose: To reauthorize the National Integrated Drought Information System.

Section 1: Short Title

The National Integrated Drought Information System Reauthorization Act of 2012

Section 2: NIDIS Program Amendments

Section 2 modifies Section 3 of the 2006 Act. Section 2(1) modifies the “In General” clause by adding the purpose of the NIDIS program “to better inform and provide for more timely decision making to reduce drought related impacts and costs.”

Section 2(2) modifies existing language by reorganizing in order to distinguish between the function of the NIDIS program in general and the early warning system specifically. The functions are largely the same as those in existing law, reorganized to reflect the distinction. The only additional function added is to allow NIDIS to “continue ongoing research activities related to drought.”

Section 2(3) also adds a new subsection (e) which requires the Undersecretary of Commerce to provide the Committee with a report 18 months after enactment. This report should (i) include an analysis of the implementation of NIDIS, including how the information, forecasts, and assessments are utilized in drought planning policy and response activities; (ii) describe specific plans, including future milestones, for continued development of such programs; and (iii) identify research, monitoring, and forecasting needs to enhance the predictive capability of drought early warnings, the length and severity of droughts, and the contribution of weather events to reducing or ending drought conditions. In developing this report, the Undersecretary is also required to consult with relevant Federal, regional, State, tribal, and local government agencies, research institutions, and the private sector.

Section 3: Authorization of Appropriations

Section 3 amends Section 4 of the 2006 Act to authorize appropriations for each of fiscal years 2013 through 2017. The discussion draft proposes \$13.5 million for each of the included fiscal years.

Chairman HALL. The Committee on Science, Space, and Technology will come to order.

And I say good morning to you and welcome, everyone, to today's hearing on "Drought Forecasting, Monitoring and Decision-Making: A Review of the National Integrated Drought Information System."

This hearing is particularly timely given the current drought conditions that are impacting a lot of the country, including much of my home State of Texas. And I am going to take a little of my time out to tell you a story about a bill I passed some five years ago, and I was over in Paris, Texas, making a speech about it, and one of my good friends over there, just to put it on me, said Congressman, will you bill it to rain? It was dry and hadn't rained in days and days. I thought about a minute or so. I said, yeah, it will. That is section four of the third page. He says really? And I said, no, I just give you a silly answer to a silly question. He was a good friend of mine, but three years later, we had, I mean, rainfall that drowned people above Texoma and all the programs—farm programs below it, ruined everybody. It rained incessantly for day and night.

I called him about 3 o'clock one morning and his wife said when he got to the phone and hit his toe on a chair and he was mad when he got to the phone, but he said hello? I said hello, Hal, you remember that question you asked me about my bill? Go outside. And I have to go through that every time I go to Paris, Texas, now. But he was a good enough friend that I could talk to him like that. But we know how important it is and really timely this hearing is, and we are very grateful to you all for your time and preparation and time to get here and the time to help us.

According to the U.S. Drought Monitor, over 70 percent of the United States is currently classified as abnormally dry or worse; and further, over half of the continental United States is experiencing moderate to extreme drought, and a third of the country is characterized as being in severe to extreme drought. These widespread conditions are negatively affecting corn and soybean crops.

As of July 17, the Department of Agriculture reported that 88 percent of the Nation's corn and 87 percent of the Nation's soybeans were in drought-stricken areas. In response to the pervasiveness of such dry conditions, Secretary of Agriculture, Tom Vilsack, designated 1,055 counties across the country as disaster areas.

Droughts, unfortunately, have long been and continue to be recurring events. Using NOAA's own document over the past 110 plus years, we see that drought has frequently occurred in the United States, the worst being the Dust Bowl years of the 1930s and the droughts of the '50s. There are some, of course, and there are those who would attribute this year's drought to climate change, but the Congressional Research Service tell us that "drought has afflicted portions of North America for thousands of years" and "history suggests that severe and extended droughts are inevitable and part of natural climate cycles."

In any event, debating the causes of drought is not to be in front of us today. The real question is what can be done to provide better and timelier information to help enable federal, state, and local governments, and individual citizens better deal with droughts' impacts, and how to afford better forecasting and quicker reactions by

governmental entities? That is kind of what I think my bill did. And my bill was really just to let them know that we were concerned about what they were going through and that we were sorry for them but there wasn't a heck of a lot we could do for them right at that time.

The National Integrated Drought Information System, established by the National Integrated Drought Information System Act of 2006, is one of such efforts that is undertaken to answer this question. Housed in the Climate Program Office within the Office of Oceanic and Atmospheric Research at NOAA, its goal is to "improve the Nation's capacity to proactively manage drought-related risks, by providing those affected with the best available information and tools to assess the potential impacts of drought, and to better prepare for and mitigate the effects of drought."

The NIDIS program developed and currently operates the U.S. Drought Portal, a website that features a range of services that are related to drought, including historical data on past droughts, current data from climate observations, early warnings about emerging and potential droughts, decision support services for managing droughts, and a forum for stakeholders to discuss drought-related issues.

NIDIS' authorization expires at the end of this year, so we will receive testimony from witnesses representing federal, state, and local governments, as well as stakeholders on the program and on the discussion draft, "The National Integrated Drought Information System Reauthorization Act of 2012."

And I welcome our witnesses and look forward to their testimony, and now recognize Ranking Member Mrs. Johnson for her opening statement.

[The prepared statement of Mr. Hall follows:]

PREPARED STATEMENT OF CHAIRMAN RALPH HALL

Good morning, and welcome to today's hearing on "Drought Forecasting, Monitoring, and Decision-Making: A Review of the National Integrated Drought Information System." This hearing is particularly timely given the current drought conditions that are impacting much of the country, including my home state of Texas.

According to the latest U.S. Drought Monitor, over 70 percent of the United States is currently classified as abnormally dry or worse; further over half of the continental U.S. is experiencing moderate to extreme drought, and a third of the country is characterized as being in severe to extreme drought.

These widespread drought conditions are negatively affecting corn and soybean crops; as of July 17, the Department of Agriculture reported that 88 percent of the Nation's corn and 87 percent of the Nation's soybeans were in drought-stricken areas. In response to the pervasiveness of such dry conditions, Secretary of Agriculture, Tom Vilsack, designated 1,055 counties across the country as disaster areas.

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The National Integrated Drought Information System (NIDIS) program, established by the National Integrated Drought Information System Act of 2006, is one such effort undertaken to answer this question. Housed in the Climate Program Office within the Office of Oceanic and Atmospheric Research at NOAA, its goal is to “improve the nation’s capacity to proactively manage drought-related risks, by providing those affected with the best available information and tools to assess the potential impacts of drought, and to better prepare for and mitigate the effects of drought.”

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NIDIS’s authorization expires at the end of this year; therefore we will receive testimony from witnesses representing Federal, State and local governments as well as stakeholders on the program, and on the discussion draft, “The National Integrated Drought Information System Reauthorization Act of 2012.”

I welcome our witnesses and look forward to their testimony, and now recognize Ranking Member Johnson for her opening statement.

Ms. JOHNSON. Thank you very much, Mr. Chairman, for scheduling this hearing to discuss legislation reauthorizing the National Integrated Drought Information System, or NIDIS.

In recent weeks, virtually every media outlet across the country has shown a map that depicts over half of the continental United States as experiencing severe drought conditions. The Federal Government has declared 1/3 of the Nation’s countries, roughly 1,300 of them across 29 States, as federal disaster areas as a result of the drought. In my own home State of Texas, over the last few years, scant rainfall and high temperatures have conspired to wreak havoc on the economy. Farmers and ranchers always bear the brunt of it. And that hits the pocketbook of every American as food prices go up.

But the damage is not limited to agriculture. For instance, in Texas, conditions are again ripe for the kind of extreme wildfires that scarred large portions of the State last year. Tourism is suffering as water levels in lakes and rivers plummet, leaving boats and marinas stranded on dry land. Communities are imposing water restrictions and exploring new and more expensive water resources and technologies. And power plants and grid operators are taking a serious look at emergency plans should cooling water supplies fall short.

Given the potential for massive economic damage, we need to recognize droughts for what they are—an extreme weather event—and design policies accordingly. Unlike disasters such as tornados, floods, and hurricanes, droughts do not leave people scrambling for cover. There are no sirens or emergency evacuations plans. The onset is slow with no defined beginning or end. The path of a drought’s destruction is sprawling, often encompassing whole regions of a country while durations are typically measured in years.

Just as we design policies, programs, and infrastructure to make predictions and limit the impacts of other extreme weather events, we should strengthen our capacity to do the same for droughts. One tool at our disposal is NOAA’s NIDIS program. In its six years of existence, NIDIS has already provided important seasonal and long-term drought information that has aided countless communities in preparing for and mitigating the impacts of drought.

But we cannot have a comprehensive approach to drought research and mitigation without exploring the potential linkages with a changing global climate. While I will be the first to urge caution in jumping to conclusions about the present-day impacts of a warming planet, I know that climatologists around the world are coming to a much better understanding of this complex relationship. We should leave the science to the scientists. To play politics and categorically deny the linkage between climate change and extreme weather is both irrational and irresponsible. Policymakers at every level have a duty to protect public welfare, and ignoring the realities of climate change simply leaves us less informed and ill-prepared for catastrophic events such as droughts and floods.

Reauthorizing NIDIS is an important step and I commend the Chairman for considering this bill. But this is only one step. While I am not typically one to look a gift horse in the mouth, I must say that the bipartisan support for NIDIS leaves me a bit baffled and my colleagues on the other side of the aisle who have otherwise been relentless this Congress in trying to undermine or outright kill every other climate-related product, service, or research program. I am encouraged to see Republicans' recognition of the valuable services of NIDIS and what they provide and just hope that other climate-related programs receive similar treatment.

Again, I thank the witnesses for joining us today, and thank you, Mr. Chairman. I look forward to the testimony.

I yield back.

[The prepared statement of Ms. Johnson follows:]

PREPARED STATEMENT OF RANKING MEMBER EDDIE BERNICE JOHNSON

Thank you, Mr. Chairman for scheduling this hearing and for this legislation to reauthorize the National Integrated Drought Information System or NIDIS.

As most of you know, every local and national media outlet has reported in the past week or two a map showing over half of the continental United States experiencing severe drought conditions. The Federal Government has declared one-third of the nation's counties—1,297 of them across 29 states as federal disaster areas as a result of the drought.

In my own home State of Texas, the reduced precipitation in addition to high temperatures have caused extreme wildfire conditions, water restrictions, a decline in tourism, reduced crop yields, and many other harmful effects. Texas has experiencing over the past year one of its most historic droughts, but thankfully last week we received a much needed and timely rainfall.

However, unlike disasters such as tornadoes and hurricanes, droughts do not have a clear beginning or end, but rather precipitation slowly declines and our reservoirs and soil becomes increasingly drier. When this happens everything from beef prices to the cost of many consumer products leave its mark on family budgets. The droughts strangle our economy and especially our agricultural economy.

While we continuously prepare for natural disasters such as floods and hurricanes, we need to continue to do more to mitigate and reduce the effects of drought.

The NOAA NIDIS program has only been in existence for six years but this program has provided important seasonal and long-term drought information that has aided countless communities to make decisions to prepare for and mitigate drought.

The federal investment in drought research and mitigation is only useful when decision-makers are continuously able to obtain and utilize the information. Fostering and supporting a research environment and framework that focuses on risk assessment, modeling, forecasting, monitoring, and management is the core of comprehensive drought information system.

And in order for us to truly be comprehensive in any of our research and mitigation plans for these extreme weather events, we must not continue to bury our heads in the sand when it comes to the larger conversation of the changing climate. You can call it global warming, climate change, whatever, but there is no doubt that our climate is changing.

Climatologists all over this country are making the link between these catastrophic events and a warming planet. Yes, to all those that say but we don't know that this is true, you are correct, we do not know. But that is the purpose of science and research. We must provide the resources and framework to our scientist to research what is going on so that we are better prepared to respond not just react.

Reauthorizing NIDIS is an important step and I commend the Chairman for this, but this is only one step. And it baffles me that we gather today primarily on one accord to support this one particular climate service when my colleagues on the other side has attempted to stifle every other weather and climate product, service, and research it could in every federal agency possible. I just don't get it.

We are here today to primarily hear from our witnesses about NIDIS and I am intrigued to learn their opinions about NIDIS and how it can continue to be most effective as well as what improvements we can make and additional research we may need to comprehensively respond to our inevitably changing climate.

Again thank you for joining us here today and I look forward to your testimony. Mr. Chairman, I yield back.

Chairman HALL. Thank you, Ms. Johnson. The gentlelady from Texas yields back.

If there are other Members who wish to submit additional opening statements, your statements will be added to the record at this point.

And at this time, I would like to begin to introduce our panel of witnesses. I plan to introduce three of the witnesses and then recognize Representative Bucshon and Representative Harris to introduce witnesses from their home States.

Our first witness is Dr. Roger Pulwarty, the Director of the National Integrated Drought Information System, and Chief of the Climate Program, Offices of Climate and Societal Interactions Division at the National Oceanic and Atmospheric Administration. Dr. Pulwarty's research and publications have been on extreme events and disaster risk-reduction in the western United States, Latin America, and the Caribbean. He served on committees of the U.S. National Academy of Science.

Our third witness is Mr. J.D. Strong, the Executive Director of the Oklahoma Water Resources Board. Under Mr. Strong's leadership, the Oklahoma Water Resources Board updated the Oklahoma Comprehensive Water Plan. It is a 50-year water supply assessment of policies and strategies designed to meet Oklahoma's future water need. Mr. Strong also oversees the administration of Oklahoma's AAA-rated 2.7 billion financial assistance program. Mr. Strong began his career at the Oklahoma Water Resources Board working as an environmental specialist.

Our next witness is Dr. James Famiglietti. James Famiglietti, did I do pretty good with that? Okay. A Professor and Director of Earth System Science at the University of California at Irvine, his research group uses a NASA gravity recovery and climate experiment mission for satellite remote sensing and to track water availability and groundwater depletion on land. Before joining the faculty at the University of California at Irvine in 2001, he was an Assistant Associate Professor in the Department of Geological Sciences at the University of Texas. Glad to have you there.

I now recognize Representative Bucshon to introduce our second witness.

Mr. BUCSHON. Thank you, Mr. Chairman.

Our second witness today is the Mayor of Indianapolis, the Hon. Gregory A. Ballard. Greg Ballard was elected the 48th Mayor of In-

dianapolis on November 6, 2007, and the City of Indianapolis re-elected Mayor Ballard to a second term on November 8, 2011.

In 2010, Mayor Ballard launched an initiative to rebuild deteriorating thoroughfares, residential streets, sidewalks, and bridges, as well as to address neighborhood drainage and flooding issues for the city, and this is on a successful pathway. Mayor Ballard also helped lead a team and they very successfully hosted this year's Super Bowl. Congratulations to the City of Indianapolis and based on that success will be competing and winning, we hope, the Super Bowl in 2018. Welcome, Mayor Ballard.

Chairman HALL. I thank the gentleman from Indiana.

I now recognize Representative Harris to introduce our final witness, final for this hearing.

Mr. HARRIS. Thank you very much, Mr. Chairman.

It is my pleasure to introduce Mrs. Patricia Langenfelter to the Committee, the President of the Maryland Farm Bureau. In addition, Mrs. Langenfelter is a member of the Kent County Planning Commission and a member of the Maryland Agricultural Fair Board. She and her husband and family operate a large grain farm in the First Congressional District and raise livestock, so she has the hands-on experience that she will bring to her testimony.

Among her recognitions, she and her husband were inducted into the Governor's Agricultural Hall of Fame in 2001 in Maryland. They were named the Mid-Atlantic Master Farmers and were honored as Cooperators of the Year by the Kent County Soil Conservation District. So again, it is a pleasure to have Mrs. Langenfelter join us this morning.

I yield back.

Chairman HALL. Thank you for yielding back and for the good introductions to both of you.

As our witnesses should know, spoken testimony is limited to five minutes after which the Members of the Committee will have five minutes each to ask questions. And we will be liberal with your five minutes. We are going to be a little tighter with those of us up here to where we are not here all day. But we are honored to have you and we thank you very much.

And I now recognize some of the witnesses to present that testimony.

Dr. Pulwarty, you are recognized for five minutes to present your testimony. You are not relegated to five minutes. Give us what you think we really need. Thank you.

**STATEMENT OF DR. ROGER S. PULWARTY, DIRECTOR,
NATIONAL INTEGRATED DROUGHT INFORMATION SYSTEM,
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION**

Dr. PULWARTY. Thank you. Good morning, Chairman Hall and Members of the Committee. My name is Roger Pulwarty. I am the Program Director of the National Integrated Drought Information System at NOAA in the Department of Commerce. It is an honor to be here today. In this testimony, I will highlight NIDIS' role in improving the Nation's capacity for understanding, predicting, and responding to drought.

As you noted, drought is part of the American experience from the Southwest long dry period in the 13th century to the events of

the '50s and the '30s in the 20th century. From 2000 to 2010, the annual average land area affected by drought in the United States was 25 percent. Recently, over the past month, more than half of the country has experienced moderate or stronger drought conditions.

NIDIS is authorized under Public Law 130 to provide an effective drought early warning system that includes indicators of drought severity and impacts reflecting regional and state differences. It is directed to do so in part by coordinating and integrated relevant federal research and by building upon existing forecasts and assessments programs.

To fulfill this task, NIDIS supports four elements, all of which work together. Firstly, Coping with Drought research, which provides extramural grants to academic and other researchers to assess the impacts of drought and to support drought decision support tools.

Secondly, the climate test-bed, which accelerates the transition of scientific research to improve the operational climate forecast products.

Thirdly, the NIDIS U.S. Drought Portal, drought.gov, provides a one-stop shop for credible and easily accessible drought-related monitoring products.

And the fourth element is a network of regional drought early warning information systems, which recognizes that drought impacts vary from region to region, as we will hear. The drought early warning system integrates information from the above three elements—from the portal, the observations, the research—and from our federal and local partners to develop drought outlooks for specific regions. A recent example of an outlook product for Wyoming, Utah, and Colorado, where I live, is provided as a supplement to this testimony.

To date, NIDIS has implemented a regional early warning system, the very first of its kind in the United States in the Upper Colorado River Basin and is developing similar systems in the Appalachicola, Chattahoochee, Flint basin and in the State of California. The approaches and tools developed for these systems are intended to be transferred to other regions such as the Pacific Northwest, the Great Plains, the Carolinas, and the Chesapeake Bay tributaries. Since the program was authorized in 2006, NIDIS has improved its effectiveness by increasing the number of States and institutions with data and capacity to inform drought risk management, the number of impact studies and user information needs assessments, and most critically, the percentage of the U.S. population covered by adequate drought early warning information systems.

I will now provide a few specific examples of NIDIS' products and services and their impacts.

Since spring of 2010, NIDIS has supported weekly drought updates and outlook webinars, the centerpiece of the Upper Colorado Drought Early Warning System, bringing together stakeholders from federal and state agencies, water conservation districts, recreation and tourism throughout the Upper Basin to raise awareness of the status of snowpack, reservoir conditions, and wildfire risks.

NIDIS products in the Colorado Basin now include improved drought indicators linking seasonal climate forecasts and monthly streamflow estimates. According to the Colorado State climatologist who leads the NIDIS webinar in the Upper Basin, he says, since the early warning system was initiated, local public and private entities in the Upper Colorado Basin have refined the U.S. Drought Monitor, the national-level product, into a more useful product for basin-specific needs. This was long sought after by groups such as the Western States Water Council and others.

The second example comes from a southeastern city. Throughout the NIDIS Coping with Drought research efforts, the researchers worked with the watershed division of Auburn, Alabama, where you have 53,000 residents, on using seasonal to yearly climate forecasts to reduce the impacts of drought. In March 2011, based on this information, the city issued a drought update in an effort to manage water demand. As a result of the city's proactive response to the impending drought, its water supply was not greatly affected. The city now uses the seasonal drought information and water supply planning and demand management on an ongoing basis.

Many other examples of research, product development, and early warning exist. As acknowledged by our partners in the States and in regional federal offices, the research, data, and outlooks supported by NIDIS, such as during the southern droughts of 2011 to 2012, significantly improved planning and coordination relative to that of previous events prior to the NIDIS legislation.

NIDIS' ability to meet drought information needs is strongly dependent on enabling observational capabilities. These include the USDA, Natural Resources Conservation Service, SNOwpack or SNOwpack TELemetry (SNOTEL) sites, the USGS Water Census under the Department of Interior's WATERSMART efforts, streamflow and reservoir levels from the U.S. Army Corps of Engineers and the Bureau of Reclamation, and the National Water Service Cooperative Observer Program. Essential research partners such as the National Drought Mitigation Center at the University of Nebraska in Lincoln work actively with NIDIS to improve operational products and to improve and inform drought planning at every level.

While drought onset is important, warning of drought intensification, warnings of duration, and the potential recurrence are also critical. To achieve the truly national drought early warning presence envisioned by the NIDIS Act requires improvements that NIDIS has begun to address but for which further advances are needed. These include understanding drought variability and forecast reliability from a season to a year and even to a decade, including understanding the role of precipitation events in ending drought; collaboration among researchers, resource management, and the public to enhance the use and the value of our existing observation networks; and the transfer of successful tools and approaches to regions not yet having active early warning systems.

Most critically is working with the private sector and others on guidance and standards for developing value-added products to support drought plans.

Key to the future success of NIDIS is a sustained national system of credible, consistent, and authoritative observations. We at NOAA are grateful for the Committee's continued interest in NIDIS. I look forward to working with you and helping the Nation and our communities take full advantage of NIDIS to anticipate and reduce the impacts of drought.

Thank you for the opportunity to speak with you.

[The prepared statement of Dr. Pulwarty follows:]

**TESTIMONY OF
ROGER S. PULWARTY
PROGRAM DIRECTOR
NATIONAL INTEGRATED DROUGHT INFORMATION SYSTEM
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE
OVERSIGHT HEARING ON**

**DROUGHT FORECASTING, MONITORING, AND DECISION-MAKING:
A REVIEW OF THE
NATIONAL INTEGRATED DROUGHT INFORMATION SYSTEM**

**BEFORE THE
COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
U.S. HOUSE OF REPRESENTATIVES**

JULY 25, 2012

Good morning Chairman Hall and members of the Committee. My name is Roger S. Pulwarty and I am the Program Director of the National Integrated Drought Information System (NIDIS) at the Department of Commerce's National Oceanic and Atmospheric Administration (NOAA). Thank you for your leadership in authorizing NIDIS in 2006 and for inviting me to provide the Committee with an update on the Program. It is an honor to be here today. My testimony will report on the information and data that have been made available to local, state, and regional water decision-makers, and how we can improve the information for anticipating and managing current and future drought conditions.

NIDIS is part of the suite of weather and climate products and services NOAA provides to improve management of sectors of our economy - including energy, agriculture, water, and living marine resources that are sensitive to variations and changes in long-term weather. Using observations, research and predictions, decision support tools, and sustained user interaction, NOAA provides assessments and predictions of weather and climate variability on timescales ranging from weeks to decades for a variety of phenomena, including drought. In this testimony, I will highlight the NIDIS' role in improving the Nation's capacity for understanding, predicting, and responding to drought.

Drought in the U.S.

Drought is part of the American experience. Severe, long-lasting droughts occurred in the Southwest during the 13th century, and in the central and lower Mississippi Valley in the 14th through 16th centuries. The great Civil War drought of 1861-1864 led to the first water rights agreement in the West - in the San Luis Valley in the state of Colorado where I live. In the 20th century, droughts in the 1930s (Dust Bowl era) and 1950s were particularly severe and widespread. In 1934, 65% of the contiguous United States was affected by severe to extreme drought. These extreme events, including droughts of

representatives from federal, state and Native American tribal agencies, and academic and private entities. In accordance with the Act, NIDIS was developed, and is continually being improved by engaging those affected by drought, integration of physical/hydrological and impacts information from observing networks, development of a suite of drought decision support tools, and the interactive delivery of information at watershed, state and county levels across the United States.

To meet these goals, NOAA supports four elements at the national level under NIDIS, all of which work together. The Drought Early Warning and Information Systems (DEWS) integrate information from “Coping with Drought” Research, the Climate Test-bed, and the Drought Portal, and fills in information gaps to provide drought early warning to drought-vulnerable regions of the Nation. Below is a brief description of each element, which I will explain in more detail below:

- “Coping with Drought” Research: Provides grants to assess impacts of drought on agriculture, ecosystems, and water resources and to develop decision support tools for regional, state, and local use. Partners include the Regional Integrated Sciences and Assessments Program and the Sectoral Applications and Research Program.
- Climate Test-beds: Research to improve predictions and links between climate forecasts and stream flow projections for particular basins. In addition, the Earth System Research Laboratory’s Physical Sciences Division, the Geophysical Fluid Dynamics Laboratory, and the Interagency Drought Task Force, all support NIDIS through research on drivers of drought frequency, onset, duration, and intensity.
- The U.S. Drought Portal: A one-stop-shop (www.drought.gov) for drought-related information and products provides credible and easily-accessible information to the public and private sectors on the web.
- Regional Drought Early Warning Information Systems (DEWS): The system facilitates ongoing assessment and scientifically-based outlooks of existing and potential drought conditions and impacts. These results are disseminated through webinars and workshops to resource managers. The system also develops user guidance, webinars, workshops with, and decision support tools for resource managers to support drought planning and risk reduction. These activities are conducted in partnership with other agencies, tribes and states, and the National Drought Mitigation Center (University of Nebraska).

Four elements of NIDIS

“Coping with Drought” (CWD) Research

CWD Research is a NOAA-supported, cross-agency grants initiative developed to support interdisciplinary research that advances the NIDIS objectives of developing drought early warning systems. Its main goal is to determine how climate data and information could help reduce vulnerability to drought by evaluating the impacts of, planning for, and responding to, drought that feed into early warnings.

Currently, two programs in the NOAA Climate Program Office support CWD - the Sectoral Applications Research Program (SARP) and the Regional Integrated Sciences

The U.S. Drought Portal

The U.S. Drought Portal (www.drought.gov) was released in 2007 as an information clearinghouse. It is a major component of NIDIS that directly provides current drought conditions, current drought impacts, and the projected length of drought. The U.S. Drought Portal provides routinely updated data products to help managers monitor and prepare for drought. Some examples of NOAA products now located on the Drought Portal include the USDM, Crop Moisture Index, ensemble water supply forecasts, and the location of relief sources as requested by the USDA. The USDM provides current drought conditions and can also be accessed directly online without going through the one-stop drought portal. The USDM also features new tools and resources developed specifically for NIDIS such as advanced mapping with GIS tools.

The NIDIS' U.S. Drought Portal experiences an average of 10,000 unique hits each month, but this number spikes significantly (60,000-70,000 at present) as drought severity increases in any given region. As part of the continuous improvement of products and services for the Nation, NIDIS is working to improve the usefulness at the local level of drought.gov by creating watershed level sub-portals hosted on the national website. In partnership with other agencies, tribes and states, the NIDIS teams coordinate and develop capacity to prototype, and then implement, regional drought early warning information systems using the information portals and other sources of local drought knowledge.

Regional Drought Early Warning Information Systems (DEWS)

Drought varies from region to region. As noted by the Congressional Research Service (2012) - extreme drought is different for Lubbock, in northwest Texas, a normally dry area, than it is for Athens, in north central Georgia, a normally wet area. In addition to physical variations, there are diverse stakeholder needs even within a single basin, such as water supply for the city of Atlanta in the northern part of the basin to irrigation for the agricultural sector (Flint) and power generation (Chattahoochee) in the middle part of the basin to ecosystem and fishery needs at the southern end of the basin (Apalachicola Bay).

As a result, NIDIS developed regional early warning information systems where drought had different physical drivers, timescales and impacts to develop tools, outlooks, and stakeholder engagement mechanisms appropriate for similar regions around the country. The locations for regional drought early warnings systems implementation are based on an assessment of drought sensitivity (including publicly identified information needs), drought type (snowpack or rainfall driven, short-term, multi-year), and management unit (watershed, city, county, etc.).

The early "prototype" for each potential Regional DEWS addresses existing barriers to cross-agency collaboration, innovations and new information to be introduced and tested, and clarifies the benefits of participation in design, and implementation and maintenance. To ensure information gaps are filled, NIDIS also conducts knowledge assessments to: (1) determine where major gaps in data, forecasts, communication, and information delivery exist; (2) identify innovations in drought risk assessment and management at state and local levels; and (3) engage constituents in improving the effectiveness of

Each product has been well-received. For example, the webinars bring together stakeholders from federal and state agencies, water conservation districts, recreation and tourism to discuss status of the snowpack, streamflow, reservoir conditions, water demand, and short-term (e.g., 5 days), seasonal forecasts (e.g., 30 days to 90 days) and long-term variations. The groups use data and information from federal and state agencies, and universities, to develop status reports and outlooks. The sessions allowed local experts and practitioners to interact and directly update the weekly USDM map with local information on drought and soil moisture conditions. This refinement at the local level was sought by states and communities in drought-sensitive regions, such as the Western States Water Council.

According to the Colorado State Climatologist, the Upper Colorado Basin has become much more engaged in the USDM weekly update cycle because of the improved local input. He added that since the NIDIS EWS has been involved, contributions to the USDM are better coordinated and it is now a more useful product. Due to increased consistency in monitoring and communications, the weekly drought assessment webinars have also improved the level of awareness of drought conditions (both physical system and impacts). Thus, the Colorado Basin EWS actively feeds into, and improves the applicability and usefulness of, the national level Drought Monitor by enhancing information about local conditions.

A Southeastern City Benefits from NIDIS

Through the NIDIS “Coping With Drought” program, researchers worked with the Watershed Division of Auburn, AL (53,000 residents) on methods using seasonal to interannual climate forecasts to reduce the impact of drought on water supply and demand. In March 2011, the city issued a drought update in an effort to curb water demand based on this information. As a result of the city’s proactive response to the impending 2011 drought, its water supply was not greatly affected. The city now uses this climate information in water management planning and demand management on an ongoing basis.

Drought-Ready Communities

The number of watershed, state and local drought and water plans using NOAA-based information has significantly increased since NIDIS was initiated. Drought preparedness advice and planning are carried out by water-dependent managers such as State Engineers, Water Availability Task Forces, farmers, agribusinesses, land managers, city councils, and others. However, the results of drought-related research, including data analyses, are not always disseminated in a timely fashion or through easily accessible or compatible modes for incorporation into risk management.

Identification and development of drought triggers and indicators requires active engagement among researchers, information brokers, and stakeholders in various sectors responsible for managing drought-related risks. Many of the lessons learned following drought events can be documented with post-drought assessments to ensure that these critical lessons are not lost. Post-drought assessments are a key step within the drought planning process, and NIDIS is learning from existing networks, such as Cooperative

Cooperative Observer Program (COOP) Monitoring network, a decentralized citizen-based effort to provide local data; the National Resources Conservation Service SNOwpack TELemetry (SNOTEL) sites; the Water Census led by the U.S. Geological Survey (USGS) under the Department of the Interior's WATERSMART efforts; and streamflow and reservoir levels from the U.S. Army Corps of Engineers and the Bureau of Reclamation. In addition to these are the state and regional partnerships such as the Western Governors Association, the Western States Water Council, various State Water Conservation Boards; and academic institutions especially the National Drought Mitigation Center (NDMC) at the University of Nebraska, Lincoln. These essential partners work actively with NIDIS on improving operational products (i.e., U.S. Drought Monitor, Drought Impact Reporter, Vegetation Drought Response Index), applications (i.e., drought planning at all levels), and education (i.e., K-12 activities) within the drought research community, media and general public to make our Nation more resilient in the face of drought and its impacts.

Next Steps for NIDIS

Key to the future success of NIDIS is an improved understanding of the drivers of drought onset, severity and duration from seasonal to yearly to decades. Success will also be heavily dependent on a sustained national system of credible, consistent, and authoritative observations.

NIDIS will continue to improve our ability to successfully measure the program's effectiveness and achievements, including measures of:

- Number and type of projects that conduct and update risk and vulnerability assessments and assessment of user needs;
- Number of institutions with increased capacity and opportunities to inform drought risk management and reduce exposure to drought risks;
- Number of staff trained to respond to and mitigate impacts of climate related events; and,
- Increased percentages of the U.S. population covered by adequate drought risk and early warning information systems.

NIDIS has also begun developing a network of state-based drought information coordinators to ensure (a) ensure strong links among Federal, state, private and tribal information providers and users, as well as (b) develop closer cross-sectoral collaboration between meteorological and hydrological services and agencies that work in urban and rural areas, such as extension services, development projects, community-based and non-governmental organizations.

To achieve a more comprehensive vision of a truly "national integrated drought information system" requires improvements that NIDIS has already begun to address, and that your interest in the program and in supporting its reauthorization will help further. These include:

- Improving the understanding and predictability of droughts across a variety of timescales for seasonal, to interannual and decadal time scales including the role of precipitation events in reducing drought duration and intensity;

The National Integrated Drought Information System (NIDIS)

The NIDIS Act prescribes an interagency approach, led by NOAA, to “Enable the Nation to move from a reactive to a more proactive approach to managing drought risks and impacts.” The NIDIS Program Implementation Team is currently composed of representatives from federal, state, and Native American tribal agencies, and academic and private entities. In its first year NIDIS completed an implementation plan with significant multi-state, multi-agency and tribal participation, it established the national-level Drought Portal (see below), and initiated the very first assessment of the status of drought early warning systems across the country. NIDIS’ ability to meet drought information needs is strongly dependent on the enabling observational capabilities of its Federal, state and tribal partner agencies.

To meet the goals of the NIDIS Act (PL 109-430), NIDIS supports four elements, all of which work together. These are:

1. **“Coping with Drought” Research** which provides extramural grants to academics and others researchers to develop drought decision support tools e.g. linking NOAA forecasts to vegetation models to produce seasonal predictions for fire management;
2. **The Climate Test-bed**, developed to accelerate advances in scientific research to improve operational climate forecast products including linking seasonal climate forecasts to monthly streamflow into major reservoirs;
3. **The NIDIS U.S. Drought Portal** (drought.gov) a one-stop-shop for providing credible and easily-accessible drought –related monitoring products. Examples of products now available on the Drought Portal include the U.S. Drought Monitor, the Crop Moisture Index, and GIS tools to enable mapping of drought conditions; and
4. **The Regional Drought Early Warning Information Systems (DEWS)** which recognizes that droughts vary from region to region. These Systems integrate research and monitoring including impacts indicators derived from the above three elements of NIDIS, and work with regional Federal and local partners to provide regionally-specific drought information outlooks. NIDIS has implemented a Regional Drought EWS, the first of its kind, in the Upper Colorado River Basin and is implementing similar systems in the Apalachicola-Chattahoochee-Flint Basin and the state of California. The approaches and tools developed for these systems are to be transferred to other drought-sensitive states and regions, such as the Pacific Northwest, the Great Plains, the Carolinas, and the Chesapeake Bay tributaries.

As illustrated in these efforts and cases outlined in the testimony, NIDIS has improved its effectiveness by increasing (a) The number of states and institutions with improved capacity to inform risk management and reduce exposure to drought risks (b) The number of staff in or working with those institutions trained to develop and communicate local drought information and help reduce impacts, (c) The number of research projects that conduct and update drought impacts and user needs assessments in drought-sensitive parts of the US and (d) the percentage of the U.S. population covered by adequate drought risk and early warning information systems. To achieve a truly “national” integrated drought information system presence as envisioned by the NIDIS Act requires improvements that NIDIS has begun to address but for which further advances are needed. These include:

- Improving the understanding of drought variability and forecast reliability across a variety of timescales from a season, to a year, to decades (including understanding the role of precipitation events in ending such droughts);
- Improving collaboration among researchers and resource managers to enhance the use and value of observation networks, impacts indicators, and predictions
- Further improving coordination between institutions that provide different types of drought information and transferring successful tools and approaches to regions not yet having active early warning systems; and
- Working with the private sector and others on guidance and standards for developing value added products to support drought plans.

Key to the future success of NIDIS is a sustained national system of credible, consistent, and authoritative observations.

Chairman HALL. And we thank you.
I now recognize Mayor Ballard to present his testimony.

**STATEMENT OF THE HONORABLE GREGORY A. BALLARD,
MAYOR, CITY OF INDIANAPOLIS**

Mr. BALLARD. Thank you, Chairman Hall, Ranking Member Johnson, Representative Bucshon, and to the full U.S. House of Representatives Committee on Science, Space, and Technology for inviting me to testify at today's hearing. My name is Greg Ballard. I am the Mayor of Indianapolis, Indiana, the 11th-largest city in the country.

Per the request of the Committee, my testimony is focused on how the drought has impacted the City of Indianapolis, our residents, and our business community. The drought of 2012 in Indianapolis is one of historic proportion and has been compounded by extreme temperatures. The Indianapolis division of Homeland Security, which considers NIDIS to be extremely important, monitored the weather using the city's Emergency Operations Center and data provided by the National Weather Service. Repeated activation of the division's extreme heat plan first prompted them to seriously consider—seriously evaluate the potential risk of drought conditions.

Similarly, Indianapolis Water Utility, which is Citizens' Water, which operates the city's water supply, used weekly drought status updates for the area as published on the U.S. Drought Monitor website, which is a part of NIDIS, to determine whether enhanced water conservation efforts were necessary in response to progressing drought conditions.

By late June, citizens had been delivering record amounts of water amidst the record-breaking heat. They estimated that 30 to 40 percent of their water load was for lawn irrigation. Citizens asked its customers to stop watering their lawns voluntarily on July 6, resulting in a modest 20 million gallons-per-day reduction in water usage.

On July 13, I enacted mandatory water-use restrictions to protect the city's dwindling water supply and ensure there was adequate water for the public safety and for their well being. These water-use restrictions included the ban on watering lawns, washing vehicles, using water to clean outdoor services such as sidewalks or driveways, filling empty swimming pools, installing new landscaping, amongst other restrictions. Water hydrants were authorized solely for fire suppression unless otherwise directed by Citizens Water. In less than a week, water usage dropped an additional 58 million gallons a day. Some businesses that depended on water to operate were exempted from the ban. Examples include nurseries, commercial car washes, golf courses, parks, and the like.

At this time, we do not have complete and comprehensive information on the impact of this drought to the residents and to government or to business in Marion County, but many businesses voiced concerns over the impacts of water-use restrictions. These include pool companies, lawn care and landscaping businesses, irrigation repair companies, painting companies, power-washing companies, car dealerships that detail their own vehicles, and contractors and builders. None of these businesses were exempted from

the mandatory water-use ban and many are small business owners who provide jobs in Indianapolis, so jobs have definitely been affected. It will be some time before we understand the full economic impact of the drought on Indianapolis.

Anecdotally, we know that the drought and the ensuing water restrictions have placed an incredible burden on businesses that rely on water to operate and the homeowners who need water to maintain their property. These restrictions have been an unfortunate but a necessary response to a severe and serious drought that is expected to persist into the fall.

Clearly, the sooner Indianapolis knows about drought conditions, the sooner we can begin planning public information and preparing our leaders and our community for water conservation. That said, the expected accuracy of the prediction would likely have to be quite high before it would result in an early implementation and mandatory restrictions.

Regarding the reauthorization of the NIDIS, I certainly support better, more timely, and more accurate drought-reporting prediction services. It certainly would help all of us.

Thank you.

[The prepared statement of Mr. Ballard follows:]

GREGORY A. BALLARD, MAYOR OF INDIANAPOLIS
 TESTIMONY BEFORE THE U.S. HOUSE OF REPRESENTATIVES
 COMMITTEE ON SCIENCE, SPACE AND TECHNOLOGY
 JULY 25, 2012



1. INTRODUCTION

My name is Gregory Ballard, and I am the Mayor of Indianapolis, Indiana, the 11th largest city in the country.

Thank you to Representative Hall and Representative Bucshon, and to the full U.S. House of Representatives' Committee on Science, Space and Technology, for inviting me to testify at today's hearing on the 2012 drought.

My testimony is focused on how the drought has impacted the City of Indianapolis, our residents, and our business community. I will also briefly discuss our information needs.

2. PLEASE DESCRIBE THE WAYS IN WHICH THE CURRENT DROUGHT HAS IMPACTED THE CITY OF INDIANAPOLIS, SUCH AS THE IMPOSITION OF ANY RESTRICTIONS, BANS OR OTHER LIMITATIONS.

The drought of 2012 in Indianapolis is one of historic proportions. Currently, rainfall in the city is more than 8 inches below normal levels. Between June 1 and July 17, Indianapolis International Airport only received nine hundredths of an inch of rain. This marks the driest stretch in Indianapolis since 1908. What has made this drought so devastating is that it began very early – in mid-May.

The drought was made even more difficult by the extreme temperatures. Summer 2012 in Indianapolis has been one of the hottest since the 1930s, with six days over 100 degrees so far and many more over 90 degrees.

In fact, on June 30, 2012, I issued a local disaster emergency declaration for Indianapolis and Marion County due to the drought and severe fire threat. In conjunction with that declaration, I signed an Executive Order banning the use of personal fireworks displays between June 30, 2012 and July 9, 2012.¹

During the last week of June 2012 and first week of July 2012, Indianapolis' local not-for-profit water utility Citizens Water, which operates the city's water supply, was delivering record amounts of water amidst the record-breaking heat. Citizens Water is a subsidiary of the local non-profit utility Citizens Energy Group (CEG).

Lawn irrigation primarily fueled this elevated demand. Citizens Water estimated that 30-40 percent of their water load was for lawn irrigation, causing water withdrawal rates to soar at the community's three reservoirs, Morse, Geist and Eagle Creek.

Morse Reservoir, which feeds two of our four water treatment plants, saw the biggest impact, with water levels falling six feet between June 1 and July 19, causing some sections of the 1,500-acre lake to go dry.

¹ <http://image.exct.net/lib/fe51c757c6400/m/3/6+30+12+EXECUTIVE+ORDER+2+2012.pdf>

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In response to these fast water withdrawal rates, Citizens Water asked its customers to stop watering their lawns voluntarily on July 6, 2012.² The voluntary ban resulted in a modest 20 million per gallon per day reduction in water usage. On July 13, 2012, as levels at Morse Reservoir continued to drop, I enacted mandatory restrictions under a Water Shortage Warning as outlined in the city's water conservation ordinance.^{3,4}

The water use restrictions mandated on July 13 included a ban on watering lawns, washing vehicles, using water to clean outdoor surfaces such as sidewalks or driveways, filling empty swimming pools, or installing new landscaping, amongst other restrictions. Water hydrants were authorized solely for fire suppression unless otherwise directed by Citizens Water.

Some businesses that depended on water to operate were exempted from the ban. Examples included nurseries, automatic or manual commercial car washes, golf courses and parks.

These water usage restrictions have been very successful. In less than a week, water usage dropped another 58 million gallons a day, for a total reduction in water usage of about 80 million gallons a day since the voluntary water use reduction was put in place. This represents a one-third reduction in total water usage.

According to Citizens Water, the reduction in demand and some much needed recent rain have stabilized levels at area reservoirs, but we are still nearly 9 inches below normal rainfall levels, so recovering from this drought could take months.

Citizens Water also developed other water management strategies that take into consideration public health and safety concerns, such as having an adequate water supply for firefighting and addressing the needs of the elderly, children, hospitals, and impoverished residents.

The response to the water use restrictions speaks very well for the Indianapolis community. Not only did the City of Indianapolis adopt the mandatory water use restrictions, but most suburban communities served by Citizens Water have also adopted the Indianapolis restrictions.

The Water Conservation Ordinance is being enforced through progressive penalties currently being administered by the Indianapolis Department of Code Enforcement (DCE). In addition to inspection resources, DCE expended a significant amount of management and administrative resources dealing with the drought.

Besides limiting water consumption, there are currently very few mitigation practices for reducing losses associated with drought.

² <http://www.citizenswater.com/AboutCitizens/News.aspx?nid=244>

³ <http://www.indy.gov/eGov/Mayor/Documents/7%202011%2012%20Mayor%20Ballard%20Delcares%20Water%20Shortage%20Warning%20In%20Marion%20County.pdf>

⁴ <http://image.exct.net/lib/fe51c757c6400/m/3/EXECUTIVE+ORDER+NO+4+2012.pdf>

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The role of the Indianapolis Division of Homeland Security (DHS)⁵ was to keep the population of Indianapolis aware of the drought conditions and to understand the physical symptoms and risks related to the extended heat and dry spells we are experiencing. DHS engages in significant coordinating activities with local, state, regional and national organizations in order to provide emergency management services for Marion County.

As part of their response, DHS coordinated a press conference with the Indiana Department of Homeland Security, Citizens Water, IPL, and the Marion County Public Health Department to bring attention to the need of protecting our most vulnerable populations and also to conserve water and electricity.

It was also during this time that law enforcement began increased enforcement when it comes to the use of fireworks and unattended cigarettes; to encourage local monitoring of water levels in towers for pressure and fire fighting; to work with local media to get the word out; to encourage electrical conservation; and also to ensure that at-risk populations are also receiving relevant and timely information and guidance on drought conditions.

DHS has found that establishing strategic partnerships with various agencies, including providing advice as subject matter experts (*i.e.* when creating policy and procedure), has enhanced its response efforts not only during drought conditions but also through other disasters and throughout crisis management in general.

Analysis by the National Weather Service (NWS) suggests the State of Indiana will see minimal drought improvement in August. Some improvement is likely by fall but moderate to severe drought could persist. NWS climate models indicate risk is still there for below normal rainfall between August and October 2012.

3. PLEASE COMMENT ON THE WAYS SUCH RESTRICTIONS HAVE IMPACTED CITIZENS OF YOUR CITY.

At this time, we do not have comprehensive, consolidated information on the monetary impact of this drought to residents, to government, or to businesses in Marion County. Droughts can also precipitate decreased tourism revenues, increased food prices, and overall decreased tax bases for local governments.

According to Citizen's Water, some residential customers expressed displeasure with the restrictions. The City of Indianapolis received over 1,000 inquiries, reports or complaints through the Mayor's Action Center (MAC), a dedicated call center for the residents of Marion County, during the first week of that the conservation measures were in place. Of those calls, 300 were informational inquiries. The remaining calls were from residents complaining about residents or businesses watering their properties.

⁵ The Division of Homeland Security (DHS) is one of four divisions of the City of Indianapolis Department of Public Safety, along with the Indianapolis Metropolitan Police Department, the Indianapolis Fire Department, and Animal Care & Control. The mission of DHS is to reduce the loss of life and property and protect our city's critical infrastructure from all types of hazards – natural or manmade – through a comprehensive program of mitigation, preparedness, response, and recovery.

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What we have experienced at the Indianapolis Department of Parks and Recreation with regard to the 2012 drought may serve as a useful proxy to the impact seen by the greater community – both home owners with lawns to maintain, as well as to local businesses seeing changes in their cost and revenues in the face of a unusually hot and dry summer.

While city pool revenues at Indy parks are up, we have lost a number of seasonal staff due to the demands of the job in high temperatures and without any rain days. Ordinarily, pool staff would have at least one day every couple of weeks when rain would force the pool to close, allowing staff to recover. Forty-five days of 90-100 degree plus temperatures in a row has taken a toll on the 16-18 years olds who keep our pools running. As a result, Indy parks will be required to reduce hours at an indoor pool to shift staff to outdoor pools until the season ends.

Indy Parks has also had to cancel a number of free concerts due to a policy that requires us to cancel a show if the heat index hits 100. Cancelling free concerts can negatively impact revenue in two ways: decline in gate admissions and difficulty in promoting other revenue generating concerts. We probably won't know the long term impact until the end of the season.

The city's golf courses are definitely struggling. While course usage remains relatively high, the unplanned expense of all of the irrigation last year and this year is making it difficult for them to stay in the black. One of our courses is facing an extra hurdle as well. The entire course is irrigated by a retention pond, and there simply is not enough water right now. Last week, they turned their water pumps on the side to get an extra 8 inches of water out of the pond, but it's not enough. If the pond runs dry, that course will face serious financial hardships due to replacing lost turf.

Maintenance is another balancing act. We won't know the full impact until the end of the season, but Indy Parks is irrigating sports fields too, and much like golf courses, we had not planned for the extra expense. Mowing at park properties is down but the irrigation plus the expense of replacing lost trees, landscaping, etc. probably won't equal out to a financial win.

4. PLEASE COMMENT ON HOW THESE DECISIONS HAVE AFFECTED THE BUSINESS COMMUNITY.

The City of Indianapolis does not have comprehensive data on the impact of these decisions on the business community or on economic development, but there certainly have been significant, anecdotal business impacts. Many businesses complained to the city because they felt that the business exemptions provided in the water ban language were inconsistent.

Others businesses voiced general concerns over the impact of water use restrictions. These include: pool companies; lawn care and landscaping businesses; irrigation repair companies; construction companies; painting companies; power washing companies; car dealerships that detail their own vehicles; and contractors and builders.

According to local media outlets, the ban on personal fireworks reduced seasonal fireworks retail sales in Indianapolis by about 90%.⁶ This is quite a significant impact for a 4-6 week annual business window.

⁶ <http://www.indystar.com/article/20120706/NEWS05/207060339/Indianapolis-fireworks-retailers-income-fizzles-customers-follow-ban>

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5. PLEASE EXPLAIN WHAT KIND OF INFORMATION IS USED TO MAKE SUCH DETERMINATIONS.

With the general awareness that Indianapolis and the Midwest experienced a mild 2011-2012 winter, and through the gathering of additional information, DHS was aware that summer 2012 was expected to be much warmer than prior summers.

Repeated and constant conditions that called for the activation of DHS' Extreme Heat Plan first prompted the division to seriously evaluate the potential risk of drought conditions.

As Indianapolis began to experience much warmer temperatures and saw a deficiency in rainfall or moisture conditions, information provided by the National Weather Service DHS began to paint a picture of much more comprehensive and wide-spread drought conditions.

DHS' coordination effort began through daily monitoring of the weather by the city's Emergency Operations Center and also by our partners with the National Weather Service. DHS also used WebEOC,⁷ a web-enabled crisis-management system that allows for real-time information sharing with its partner agencies, including public and private organizations throughout Marion County.

Citizens Water has a very comprehensive long-term water supply planning process that focuses on regional supply planning, water conservation, identifying new sources of supply and more efficient use of current supply sources.

As mentioned earlier in my testimony, Citizens Water engaged the Department of Code Enforcement (DCE) and the Mayor's Office in discussions when they felt that initial water conservations measures were warranted, approximately 3-4 weeks prior to the July 13th water ban declaration. These ongoing discussions centered on the severity of the conditions, implementation policy, and resource availability. After the water ban was activated, Citizens Water and DCE had nearly 2 days to coordinate messaging and identify potential issues/inquiries relating to the ban.

The Indiana Department of Homeland Security and National Weather Service also keep us informed on current water conditions in Indiana. Information is shared through maps of the U.S. Drought Monitor, State Severity Indices, etc. It is through all of this information that the State warned that a major drought will persist for the rest of summer in Indiana.

The State of Indiana uses a warning system that does aid us locally on decisions regarding human and environmental health and welfare during drought. It is through a water shortage warning that we begin to prepare for a coordinated response.

Citizens Water used its Drought Management Guidelines to mitigate the impact of the drought and ensure long-term water supply for the community. The utility's guidelines call for frequent communications with utility customers, coordination with city government, and water conservation measures triggered by operating parameters such as reservoir and river levels.

⁷ http://esi911.com/esi/index.php?itemid=30&id=14&option=com_content&task=view

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The guidelines used by the water utility uses various triggers to determine enhanced water conservation efforts necessary in response to progressing drought conditions. One of these triggers in the drought management guidelines for Indianapolis is based on the drought status for the area as published on the U.S. Drought Monitor web site, which is part of the National Integrated Drought Information System. These status updates are made weekly to the U.S. Drought Monitor website, and are checked by Citizens Water as they are updated.

The designation of "drought status" on the U.S. Drought Monitor website was used in media communications to help condition customers to water reduction efforts, to emphasize the seriousness of the drought situation, and most likely helped with the cooperation by the vast majority of customers with complying with the lawn irrigation ban once that was enacted.

6. WAYS IN WHICH THIS INFORMATION COULD BE IMPROVED OR HOW ADDITIONAL DATA COULD BETTER INFORM THIS DECISION-MAKING PROCESS IN THE FUTURE

The sooner we know about drought conditions, the sooner we begin planning public information and preparing our leaders and the community for water conservation. However, the expected accuracy of the prediction would likely have to be quite high before it would result in an earlier implementation of mandatory restrictions.

Improvements in drought prediction tools would have the potential to provide earlier information that could be used in water supply and demand planning and decision-making related to appropriate responses. It certainly would help with communicating the needs related to voluntary reductions and would hopefully promote greater response to voluntary requests.

7. COMMENTS ON THE COMMITTEE'S DRAFT NIDIS REAUTHORIZATION LEGISLATION

Mayor Ballard supports better, more timely and more accurate drought reporting and prediction services.

Chairman HALL. Thank you, Mayor.
I now recognize Mr. Strong for five minutes to present his testimony.

**STATEMENT OF MR. J.D. STRONG,
EXECUTIVE DIRECTOR,
OKLAHOMA WATER RESOURCES BOARD**

Mr. STRONG. Thank you, Mr. Chairman and Members of the Committee, and for the opportunity to appear before you today to discuss an issue of critical importance to Oklahoma and other Western States, and that is drought monitoring, forecasting, and coordination. My name is J.D. Strong. I serve as Executive Director of the Oklahoma Water Resources Board. In addition to coordinating State drought monitoring activities, my agency carries out numerous water-related responsibilities for the State of Oklahoma, all of which are heavily impacted and influenced by drought. While I testify today as Director of the Oklahoma Water Resources Board, the State's water management agency, I know through my involvement in coordination with those in the Western States Water Council and Western Governors' Association that many other Western States share similar thoughts and suggestions about reauthorization of the National Integrated Drought Information System, or NIDIS.

Why is drought such a challenge for us? And like other natural disasters such as floods and tornados, which strike suddenly and generally end within minutes or days, the effects of drought settle in slowly and often subtly over months or even years. That is why it is often referred to as the creeping disaster. It is often difficult to know when a drought has started and even more challenging to know when droughts will end.

Additionally, and partly because of its subtle onset, society too often falls into what we call the "hydro-illogical cycle." That is we ignore drought until the situation is dire, we lament the impacts, justifiable scream for help, and clamor for emergency funding, but invariably it rains, at which point we forget there was ever a problem and go back to business as usual. We must break this cycle.

Drought also means different things to different regions and different water users, which highlights the importance of focusing research and monitoring and reporting not so much on a national scale but on measures and predictions that are relevant to state, regional, and local and tribal stakeholders.

Oklahoma is no stranger to drought. Some 80 years removed from the infamous Dust Bowl era, we are experiencing our third major drought episode within just 6 short years. Virtually every year in Oklahoma, 1/4 or more of the State is classified in at least the severe drought category.

Notably, my agency and the Water Development Board and the Chairman and Ranking Member's Home State of Texas were created in 1957 on the heels of what is the worst drought of record on the Great Plains. We have come far in Oklahoma in understanding and mitigating droughts' impacts. Oklahoma's world-renowned weather research community utilizing our 120 Mesonet Climate Monitoring Stations scattered across the State has developed advanced tools utilizing real-time information on precipita-

tion, temperature, soil moisture, and many other parameters impacting water management and water stakeholders. Augmenting this essential weather data and research conducted at the National Weather Center is streamflow information collected by the USGS Cooperative Streamgaging Program, Corps of Engineers reservoir gages, Landsat thermal imaging for evapotranspiration, and numerous other sources of critical data.

Still, Oklahoma, like the Nation in general, remains largely vulnerable to the vagaries of drought and its annual multi-billion dollar impacts. Reducing those impacts requires improved insight into this recurring disaster. That, as you know, is the goal of the still relatively new NIDIS program.

Thanks largely to the foresight and resolve of Congress, including the leadership of Chairman Hall, and with much input and assistance from organizations like the Western Governors' Association, the National Integrated Drought Information System was launched in 2006. In short, it was created to focus research on advancing our predictive capabilities while establishing a communication link between the scientific community and those most affected by drought.

What has it accomplished? From data integration to improved communication of outlooks to engagement with local, state, tribal, and regional and federal offices, NIDIS has established a more coordinated and effective drought monitoring and response network. Prior to NIDIS, there was no such coordination, and similarly, stakeholder involvement was lacking to nonexistent.

In Oklahoma, NIDIS has a strong presence due to the active involvement of climate scientists at the National Weather Center, as well as funding the program provides to the Southern Climate Impacts Planning Program, one of NOAA's Regional Integrated Sciences and Assessment, or RISA, teams. Information provided through NIDIS Drought Portal has made my agency's job much easier in providing continuous updates of continuing drought conditions, allowing us to focus our attention and assistance on regions of the State that warrant heightened mitigation efforts. Of particular importance, NIDIS provides the seasonal drought outlook from the NOAA Climate Prediction Center and hydrologic forecasts from the NOAA River Forecast Center.

While NIDIS has been largely successful, much work remains, including more and improved monitoring tools and predictions, expanded coordination between sectors and agencies, and integration of drought preparedness and response in the State Water and Hazard Plans. More importantly, we eagerly await development of a drought early warning system for our area, which is a key goal of the program and central to effective drought preparedness and response.

Specific to the draft legislation, we appreciate Chairman Hall's sponsorship of NIDIS reauthorization and applaud this Committee for giving it due consideration. Specifically, I would respectfully urge the Committee to add language explicitly focusing on those NIDIS components that are still lacking full implementation, perhaps including a firm requirement and deadline for development of early warning systems and drought prediction strategies.

In closing, drought is a real and present danger that affects this Nation to the tune of billions of dollars and countless lives every year. As my Congressman, Frank Lucas, who I know is chairing an Ag Committee meeting at this moment, can attest from his Chairmanship the disaster assistance that federal and state governments provides is nothing compared to the minute sums spent on data collection, analysis, and reporting, and yet decisions that involve billions of taxpayer dollars and American lives should be well informed.

We as a Nation can ill-afford to step backwards when dealing with what is arguably the Nation's most menacing and costly natural disaster. Rather, we need to take the next step forward by building on the fundamental work accomplished under NIDIS since 2006 to establish the most valuable product of this endeavor—an efficient and accurate early warning system that can save both money and lives. Even incremental improvements in the accuracy of predictions regarding the location, duration, and intensity of drought, particularly if on a seasonal to one-year scale would be extraordinarily beneficial in establishing contingencies and informing decisions made by water managers, farmers, ranchers, energy producers, and countless other water interests.

I respectfully urge reauthorization of NIDIS with particular emphasis on those components not fully operational at this point in time, as well as necessary funding to ensure its full implementation. Thank you.

[The prepared statement of Mr. Strong follows:]

Testimony by
J.D. STRONG
EXECUTIVE DIRECTOR, OKLAHOMA WATER RESOURCES BOARD

On Behalf of
THE STATE OF OKLAHOMA, OKLAHOMA WATER RESOURCES BOARD
RE: Reauthorization of the National Integrated Drought Information System

Before the
House Committee on Science, Space, and Technology
July 25, 2012

Mr. Chairman and members of the Committee, thank you for the opportunity to appear before you today to discuss an issue of critical importance to Oklahoma and other western states—drought monitoring, forecasting and coordination. My name is J.D. Strong, and I serve as the Executive Director of the Oklahoma Water Resources Board.

In addition to coordinating state drought monitoring activities, the OWRB administers water rights authorizing the use of surface and groundwater across Oklahoma; conducts studies of stream systems and groundwater basins to determine water available for allocation; licenses water well drillers; coordinates floodplain management activities; administers a dam safety program; develops and maintains Oklahoma's Water Quality Standards; directs water quality monitoring programs to prioritize pollution control and mitigation activities; supports state activities in four interstate stream compacts; updates the Oklahoma Comprehensive Water Plan and participates in cooperative water planning studies; and administers the state's most popular financing program to fund water and wastewater projects. To varying degrees, drought impacts virtually every one of our programs and responsibilities.

While I am testifying today as Director of Oklahoma's water management agency, I know through our involvement and close coordination with the Western Governors' Association and Western States Water Council that many western States share similar thoughts and concerns about reauthorization of the National Integrated Drought Information System (NIDIS).

Drought in Oklahoma

Before I comment on NIDIS reauthorization, I would like to underscore the significance of drought. Unlike other natural disasters—such as floods, tornadoes, and hurricanes, which strike suddenly and generally end within minutes or days—the effects of drought settle in slowly and often subtly over months or even years. It is often difficult to know when a drought has started, and even more challenging to know when droughts will end. Our society often falls into what we call the “hydro-illogical cycle;” that is, we ignore drought until the situation is dire, lament the impacts, justifiably call for help, and clamor for emergency funding. But invariably it rains, at which point we forget there was ever a problem and go back to business as usual. We must break this cycle.

Oklahomans are notoriously well-acquainted with drought, its devastating impacts and often lasting effects. Some 80 years removed from the infamous Dust Bowl era, drought has become a routine and lasting event in our state, every bit as much as floods or tornadoes, and its social, economic and environmental repercussions pose an unyielding threat.

- Create a drought early warning system capable of providing accurate, timely and integrated information on drought conditions to facilitate proactive decision-making;
- Provide interactive delivery systems, including an Internet portal, of easily comprehensible, standardized products, such as forecasts and outlooks; and
- Provide a framework for education and information exchange between drought experts and the affected community.

In short, NIDIS utilizes research to advance our predictive capabilities while establishing a communication link between the scientific community and those commonly affected by drought.

NIDIS Benefits

From data integration to improved communication of outlooks, to engagement with local, state, tribal and regional federal offices, NIDIS has worked to establish a more coordinated and effective drought monitoring and response network throughout the U.S. In Oklahoma, NIDIS has a strong presence due to the active involvement of climate scientists at the National Weather Center as well as funding the program provides to the Southern Climate Impacts Planning Program (SCIPP), one of NOAA's Regional Integrated Sciences and Assessments (RISA) teams who work to connect scientific expertise with stakeholder needs on a range of regionally specific climate issues. For SCIPP, the University of Oklahoma and Louisiana State University partner to serve stakeholders in Texas, Oklahoma, Louisiana, Arkansas, Mississippi and Tennessee. The SCIPP states are unique in that this region is extraordinarily influenced by extreme weather events.

Information provided through the NIDIS Drought Portal is utilized by the OWRB to produce continuous updates, in both dry and wet times, of current drought conditions—a charge of Oklahoma's Drought Management Plan, established in 1996. These updates, called the Oklahoma Water Resources Bulletin, present a detailed summary of key drought indicators provided through the Portal—such as precipitation departures, the standardized precipitation index, streamflow, and crop status reports—along with current information on state reservoir storage and related factors. This regular report is distributed to state and federal agencies, water suppliers, the Governor, legislators, and the media. The Bulletin provides an extremely accessible and understandable overview of drought conditions and highlights regions of the state that warrant additional attention and potential mitigation. I understand that NIDIS is working with states, such as Colorado, to implement similar regular update strategies.

NIDIS assessment tools and products also inform Oklahoma's contribution to the U.S. Drought Monitor. This improved, localized information and suite of new assessment products, such as soil moisture, vegetation health, and evaporative water losses, improves the quality of advice Oklahoma is able to provide to the national authors. More precise depictions help ensure that Oklahoma receives commensurate federal aid in the event of federal disaster designations.

Of particular importance, NIDIS provides the seasonal drought outlook from the NOAA Climate Prediction Center and hydrologic forecasts from the NOAA River Forecast Center. And with NIDIS assistance, the Southern Regional Climate Center is currently developing an integrated reservoir database, which is of special importance to Oklahoma citizens where large federal reservoirs, in particular, provide a key water supply source.

warning system is the most worthwhile and anticipated product that the NIDIS program could possibly develop. A national map may tell a good story, but users need more tailored information in order to create opportunities for investment and make management decisions.

Specific Comments on Draft Legislation

I sincerely appreciate Chairman Hall's sponsorship of NIDIS reauthorization and pray this Committee and Congress will give it due consideration. Specifically, the new draft reauthorization language requires NOAA, within 18 months of enactment, to prepare a report to Congress on its progress in implementing the program, including an identification of research, monitoring, and forecasting needs for enhancing predictive capability. I urge the Committee to add language explicitly focusing on those NIDIS components still lacking full implementation, particularly the early warning system and drought prediction strategy.

I also respectfully call to your attention Western Governors' Association Policy Resolution 11-7 entitled "Water Resource Management in the West," which was passed by the Governors about this time last year. Section B-7 of the Governor's Policy Statement recommends continued development of the NIDIS program, in particular implementation of regional drought early warning systems.

Summary

In summary, we as a nation can ill afford to regress when dealing with what is arguably the nation's most menacing and costly natural disaster, as evidenced by the billions of dollars each year attributed to the impacts of all too common drought episodes. Rather, we need to take the next step forward by building on the fundamental work accomplished under NIDIS since 2006 to establish the most valuable product of this endeavor—an efficient and accurate early warning system that can save both money and lives. Even incremental improvements in the accuracy of predictions regarding the location, duration and intensity of drought, particularly if on a one-to-two year time scale, would be extraordinarily beneficial in establishing contingencies and informing decisions made by water managers, farmers, ranchers, power producers, and countless other water interests.

In conclusion, I respectfully urge reauthorization of the National Integrated Drought Information System—with particular emphasis on those components not fully operational—as well as necessary funding to the National Oceanic and Atmospheric Administration that will ensure its full implementation.

Thank you.

For further information on organizations mentioned in this testimony:

- Oklahoma Water Resources Board: <http://www.owrb.ok.gov/>
- Oklahoma Water Resources Bulletin: <http://www.owrb.ok.gov/supply/drought/bulletin.php>
- Oklahoma Climatological Survey: <http://climate.ok.gov/>
- Southern Climate Impacts Planning Program: <http://www.southernclimate.org/>
- National Weather Center: <http://www.nwc.ou.edu/>
- Western Governors' Association: <http://www.westgov.org/>
- Western States Water Council: <http://www.westgov.org/wswe/>

collaboration between the research and management communities to ensure relevant information is developed and shared with decision-makers. Basic information on the status, trends and projections of our water resources is essential to sound water management.

1. **Basic Water Data:** Western Governors support several federal programs that are particularly critical in this regard, including but not limited to the USGS Cooperative Water Program and National Streamflow Information System, the NRCS Snow Survey and Water Supply Forecasting Program, and the NASA Landsat Program with its thermal infrared sensor (TIRS). Western Governors are concerned about declines in federal spending for these and other programs that provide important water supply information and believe that such programs should be fully funded by Congress and implemented by the federal agencies. Moreover, a general lack of comprehensive and coordinated programs for measuring and monitoring water use at all levels of government contributes to unacceptable uncertainty on the demand side of the equation, and Western Governors support recent federal efforts to address this need. They also support federal efforts to coordinate water data gathering and information programs across multiple agencies.
2. **Forecasts and Models:** Western Governors call on the federal government to work with Western states to develop tools and models that better enable the synthesis, visualization and evaluation of water-related data. This includes the development of climate models that provide useful information for state water resource managers, utilities and decision-makers in the Western states. Western Governors recommend the National Oceanic and Atmospheric Administration take the lead in improving forecasts on multiple geographic and temporal scales.
3. **Information Services:** Western Governors encourage federal agencies to partner with states in the gathering, coordination and effective dissemination of water-related data between the federal government and states. The National Integrated Drought Information System (NIDIS) is a successful model of state-federal collaboration in the development of information services. Western Governors support the development of other important information services, designed in conjunction with the states, including a national climate service that would incorporate and coordinate existing climate and water data collection and analysis programs and services. They further support collaborative management and adaptation programs, such as the Regional Integrated Sciences and Assessments.

Water Resource Planning

Western Governors believe solutions to water resources challenges require an integrated approach and greater partnership among state, tribal, local and federal agencies. Water resource planning should consider collectively the full range of water resource needs; develop from the bottom up effective solutions that are complementary rather than conflicting; and provide direction for specific solutions and the most appropriate entities to implement them based primarily on a watershed approach.

4. **State Integrated Water Resource Planning:** Western Governors support *integrated water resource management* and encourage the development of comprehensive water

9. **Energy Development:** Western Governors recognize that energy development and electricity generation may be a significant driver of future water demands. Western Governors recommend increased coordination across the energy and water management communities and support on-going work to assess the interconnection of energy and water through the Regional Transmission Expansion Planning Project for the Western interconnection and similar efforts.
10. **Intergovernmental Cooperation:** Western Governors recognize the important role of federal agencies in supporting sound water resource management in the Western states. Governors appreciate the efforts of federal agencies to coordinate water-related activities with the Western states through the 'Western States Federal Agency Support Team' (WestFAST) and recommend the continuation of this key state-federal partnership.

Water Resource Solutions

Western Governors recognize that there is no "silver bullet" solution to water resource challenges and support a mix of efficient and cost-effective strategies that account for the full range of water supply and environmental needs.

11. **Infrastructure:** Western Governors support investment in water supply and water quality infrastructure. Infrastructure investments are essential to our nation's continued economic prosperity and environmental improvements, and they assist state and local entities in meeting federally mandated standards. Infrastructure investment is particularly critical now, as much of the water infrastructure that has served the West for decades is aging and in dire need of repair. Specifically:
 - a. As the economy recovers, all levels of government should be encouraged to increase their investment in water infrastructure and adopt adequate life-cycle asset management practices that include pricing policies, project prioritization and sufficient revenues to cover the costs of service.
 - b. To help states address water infrastructure needs, Congress should provide stable and continuing federal appropriations, increased by a construction inflation index, to the Clean Water Act and Safe Drinking Water Act State Revolving Funds. Further, Congress should increase appropriations from the Reclamation Fund for authorized purposes to match average annual fund receipts. Congress should pass the Corps of Engineer's Water Resource Development Act (WRDA) legislation on a regular schedule and increase funding levels so all projects and studies authorized in WRDA can be completed in a timely manner. Congress also should consider facilitating greater investment in water infrastructure, such as through an infrastructure bank or water trust fund.
 - c. Congress should remove the state volume caps for private activity bonds used for water and wastewater projects, provide guaranteed tax-exempt status for bonds issued by state or local agencies to finance water infrastructure, provide loan guarantees, and otherwise support and encourage alternatives to direct federal investment of limited general funds.

16. **Recreational and Ecological Values:** Western Governors believe states should strive to maintain ecological services, recreational amenities and species needs when managing and developing water resources. States and federal agencies should coordinate efforts to avoid the listing of water-dependent species under the Endangered Species Act. When ESA listings cannot be avoided, parties should promote the use of existing state tools, such as state in-stream flow protections to conserve and recover species.

C. **GOVERNORS' MANAGEMENT DIRECTIVE**

1. This resolution is to be posted on the Western Governors' Association Web site.
2. The Western Governors' Association and the Western States Water Council should continue to develop coordinated positions on specific water resource issues on behalf of Western states and work to communicate these positions to Congress and federal agencies.
3. Western Governors direct the Western Governors' Association and the Western States Water Council to:
 - a. Update information and compile a report on Western state water resources infrastructure financing authorities, funding sources, policies and programs.
 - b. Work with the USGS, EPA, NRCS, and other federal agencies responsible for water-related data collection, to explore the development of a consistent, systematic, state-led approach to collecting and sharing information about water supply, demand and management options that inform state water supply planning.
 - c. Develop an agreement with the National Oceanic and Atmospheric Association on the delivery of climate-related information to inform water management (and other resource and management) decisions, ensuring that new services meet the needs of states and other on-the-ground resource managers.
 - d. Conduct a study of water transfers in the Western United States with a focus on developing a tool box of institutional and management strategies that states can employ as appropriate.
 - e. Examine the relationship between future energy development and water supply; identify the implications of water supply for the electric grid; and recommend policies or programs to facilitate sustainable energy development in the context of economy-wide water availability, working through the Regional Transmission Expansion Planning project.
 - f. Continue to work with the Ad Hoc Group on Indian Water Rights for purposes of advancing negotiated settlements of Indian land and water rights disputes.
 - g. Collaborate on an update to the *Water Needs and Strategies Report* for 2012 that would include a shared vision for water that recognizes the important role of state leadership and highlights the need for continued investment in water resource planning and management throughout the West and the Nation.

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Chairman HALL. And thank you. I now recognize Dr. Famiglietti for five minutes to present his testimony.

**STATEMENT OF DR. JAMES FAMIGLIETTI,
PROFESSOR AND DIRECTOR, EARTH SYSTEM SCIENCE,
UNIVERSITY OF CALIFORNIA, IRVINE**

Dr. FAMIGLIETTI. Chairman Hall, Ranking Member Johnson, and other Members of the Committee, thank you for the opportunity to provide testimony today. My name is James Famiglietti and I am a Hydrologist and Professor at the University of California, Irvine, and formerly at the University of Texas.

Drought is an insidious and patient killer of food and fuel crops, of livestock, of flora and fauna, and of humans. And it has emerged as a major threat to our Nation's food, health, economic, and water security. Unfortunately, these all may be at greater risk in the coming decades as increasing temperatures are expected to result in more frequent and prolonged drought.

In spite of its enormous emotional and financial toll, current investment in drought forecasting, monitoring, and planning tools such as those that we are discussing today remains far too small to effect timely progress towards critical improvements. The stated goals of NIDIS are absolutely essentially for a national-scale drought monitoring prediction and awareness strategy. I fully support the continuation and proposed increase in NIDIS funding.

For example, some key NIDIS successes are coordination of drought research in the United States. The NIDIS drought early warning system is emerging as a crucial step towards diminishing drought impacts and cost. NIDIS funding has supported many innovative research projects that are yielding insights towards improved drought monitoring prediction and mitigation. One of the most widely used and visible drought awareness tools is the U.S. Drought Monitor, an important partner of the NIDIS program.

The gaps identified in the NIDIS implementation plan drastically limit the confidence of predictions and the accuracy of early warning systems. Of these, in my opinion, the most important are related to deficiencies in the Nation's hydrological modeling assets, a lack of observations of the water environment, and their integration. All of these underlie drought information systems like NIDIS. In fact, our Nation's ability to monitor and predict the state of its water environment is well behind where it needs to be to address not only issues of drought but also of water availability, flooding, groundwater depletion, of human versus ecological water requirements, and of the impacts of global change. Moreover, we are falling behind the capabilities of other nations while significantly constraining our domestic efforts to ensure sustainable water management.

The following are critical steps toward an advanced drought monitoring and prediction strategy. First, more realistic computer simulation models are needed that represent all major natural and human components of the water cycle; a significant acceleration in the development of advanced computer models for hydrology and water management, including an integrated national water model, is essential for effectively managing drought and a range of critical water issues.

Second, we must fill in fundamental knowledge gaps of Earth's water environment at the surface and the shallow subsurface. We know very little about the unseen topography beneath the water surface—for example, the bathymetry of thousands of river channels, floodplains, and lakes; or of soils or hydrogeology at the national scale.

Third, we need your support for key satellite observations of water. Since Dr. Pulwarty summarized the need for continued ground base measurements, let me emphasize those for satellites. Several current and future NASA missions are making fundamental contributions towards understanding drought and improving its prediction. The GRACE mission has been quite successful in identifying areas of water stress and of groundwater depletion.

The figures shown on the screen, for example, shows areas which have lost significant amounts of water over the last ten years, shown in red, due either to ice melting or groundwater depletion while the areas shown in blue have gained water. Note that the regions where groundwater is being rapidly depleted are in the arid and semiarid parts of the world where natural replenishment of aquifers is limited and where population is growing. In other words, it won't be getting any better in those locations.

Upcoming mass emissions such as the Surface Water and Ocean Topography, or SWOT mission, will map changes in surface water storage, including areas of high and low river flows, lake and reservoir levels. The continued support of Congress for these core water missions is essential for effective and sustainable water management, including advancing our drought preparedness capabilities in the United States.

Water is on a trajectory to rival energy in its importance in the United States, yet the investment in observations, models, and exploration of the subsurface pales in comparison. We have the potential to be world leaders in characterizing, monitoring, and predicting all aspects of the water environment from forecasting droughts and floods to science-informed, technology-based, long-term, sustainable water management. The vision and the technology are in place. Leadership in Congress is what will make it a reality.

Thank you again for this opportunity to testify today.

[The prepared statement of Dr. Famiglietti follows:]

**WRITTEN TESTIMONY OF
DR. JAMES S. FAMIGLIETTI
DIRECTOR, UC CENTER FOR HYDROLOGIC MODELING
PROFESSOR OF EARTH SYSTEM SCIENCE
PROFESSOR OF CIVIL AND ENVIRONMENTAL ENGINEERING
UNIVERSITY OF CALIFORNIA, IRVINE**

**HEARING ON
DROUGHT FORECASTING, MONITORING AND DECISION-MAKING:
A REVIEW OF THE NATIONAL INTEGRATED DROUGHT INFORMATION SYSTEM
COMMITTEE ON SCIENCE, SPACE AND TECHNOLOGY
U.S. HOUSE OF REPRESENTATIVES
JULY 25, 2012**

Chairman Hall, Ranking Member Johnson and other members of the committee: thank you for the opportunity to provide testimony on the National Integrated Drought Information System (NIDIS).

My name is James Famiglietti. I am a hydrologist and professor on the faculty at the University of California, Irvine, with appointments in the Department of Earth System Science and the Department of Civil and Environmental Engineering. I am also the Founding Director of the UC Center for Hydrologic Modeling. My research group uses satellite remote sensing and develops advanced computer models to track water availability on land, including the occurrence of the hydrologic extremes of flooding and drought. It is on the strength of nearly 30 years of research, teaching and service to the water science and engineering community that I offer the following testimony.

INTRODUCTION

Drought is an insidious and patient killer – of food and fuel crops, of livestock, of other flora and fauna, and of humans. It causes billions of dollars of damage each year in the United States, and perhaps much more when its far reaching effects, for example, on water availability, on food and energy production and prices, or on the frequency of fires, are accounted for. Clearly, drought has emerged as a major threat to our nation's food, health, economic and water security. Unfortunately, these all may be at greater risk in the coming decades, as increasing temperatures are expected to result in more frequent and prolonged drought. In spite of its enormous emotional and financial toll, current investment in drought forecasting, monitoring and planning tools, such as those that we are discussing today, remains far too small to affect timely progress towards critical improvements.

The National Integrated Drought Information System (NIDIS), first proposed by the Western Governors' Association Report (2004) "Creating a Drought Early Warning System for the 21st Century: The National Integrated Drought Information System" made the case for a national-scale, coordinated drought monitoring and forecast system.

Among the goals listed in the NIDIS Implementation Plan (2007) are: 1) developing leadership and partnerships to successfully implement NIDIS; 2) fostering and supporting a research environment that focuses on risk assessment, forecasting and management; 3) the creation of a drought early warning system; 4) development of an internet portal for disseminating early warning system information; and 5) providing a framework for increasing public awareness and education of drought issues.

These goals are absolutely essential for a national-scale drought strategy and I fully support the continuation and proposed increase in NIDIS funding. For example, some key NIDIS successes are:

- Coordination of drought research in the U.S. Without NIDIS this work would be less organized and efficient.
- The NIDIS drought early warning system, which is in development but not yet implemented nationally, is a crucial step towards diminishing drought impacts and costs
- NIDIS funding has supported many innovative research projects that are yielding insights toward improved drought monitoring, prediction, and mitigation (Pulwarty, 2011).

One of the most widely used and visible drought awareness tools is the U. S. Drought Monitor (USDM), an important partner of the NIDIS program. The USDM, first developed around 2000 by a volunteer consortium, is now mandated by law, yet in my understanding, remains unfunded as a project (though individual researchers may receive funding).

IMPROVING NIDIS

The NIDIS Implementation Plan (2007) identifies several gaps in its longer-term development strategy. These gaps drastically limit the confidence of predictions and the accuracy of early warning systems. Of these, in my opinion, the most important are related to deficiencies in the nation's hydrological modeling assets, a lack of observations of the water environment, and their integration. It is important to recognize that these issues plague all aspects of water research, forecasting and planning. Our nation's ability to monitor and predict the state of its water environment is well behind where it needs to be, to address not only issues of drought, but also of water availability, flooding, groundwater depletion, of human versus ecological water requirements, and of the impacts of global change (Famiglietti et al., 2011). Moreover, we are falling behind the capabilities of other nations, while significantly constraining our domestic efforts to ensure sustainable water management (Famiglietti, 2012).

Critical Needs

More realistic computer simulation models. While the research community that develops our nation's computer models for hydrologic prediction has made great progress in the past few decades, enormous challenges lie ahead. Most of our regional and national

models do not effectively the represent the coupling among snow, surface water and groundwater supplies. In some cases, the representation of rivers and groundwater is absent. The inclusion of human water management (groundwater pumping, reservoir storage, conveyance), a dominant control on water storage and movement, is effectively absent. A major acceleration in the development of advanced computer models for hydrology and water management, including an integrated national water model, is essential for effectively managing drought and range of critical water issues. It is critical that these advanced models readily integrate core satellite and ground-based measurements (see below), and that they evolve with advances in computing power and the structure of the internet.

Fill in fundamental knowledge gaps. Knowledge of Earth's water environment at the surface and shallow subsurface remains insufficient. Consequently, it is a major barrier to minimizing risk and maximizing resiliency to events like prolonged drought and extreme flooding. We know very little about the unseen topography beneath the water surface, for example, the bathymetry of thousands of river channels, floodplains, and lakes. An accurate, national-scale soil depth map does not exist, nor does a 3-dimensional map of the nation's hydrogeology. All are essential inputs into our computer models, yet without them, we are forced to guess at the values of these critical parameters. Major efforts at synthesizing existing information, and exploring and mapping what is as yet unknown, is an important frontier that can vastly improve drought preparedness and water management capabilities.

Support for key observations. Modern water observing systems include a dense network of ground-based measurements and satellite measurements to document status and changes over larger, regional areas. Key ground-based measurements include the U. S. Geological Survey stream gaging and groundwater monitoring programs, and the U. S. Department of Agriculture Soil Climate Analysis Network (SCAN; <http://www.wcc.nrcs.gov/scan>) sites for measuring soil wetness. The number of active stream gauges is in decline in the U.S., and in many states, reporting of groundwater pumping rates is not required. A reevaluation of this situation, including the number of active stream gauging stations, groundwater monitoring wells and reporting requirements would benefit all aspects of water availability, flood and drought management. The SCAN program is young and could be grown significantly to create a far better picture of water available for crops than is currently available.

Satellite observations, and in particular NASA missions, are providing new insights into rainfall rates (Tropical Rainfall Measurement Mission, TRMM), and areas of water stress and groundwater depletion (Gravity Recovery and Climate Experiment, GRACE). Upcoming NASA missions, such as the Surface Water and Ocean Topography (SWOT) mission, will map changes in surface water storage, including areas of high and low river flows, lake and reservoir levels. The Soil Moisture Active Passive (SMAP) mission will ultimately provide maps of the water content in surface soils that can be used to more effectively and efficiently schedule irrigation. The Global Precipitation Mission (GPM) will continue the success of the TRMM mission by expanding its coverage from tropical to global. The continued support of Congress for these core water missions is essential

for effective and sustainable water management, including advancing our drought preparedness capabilities in the United States.

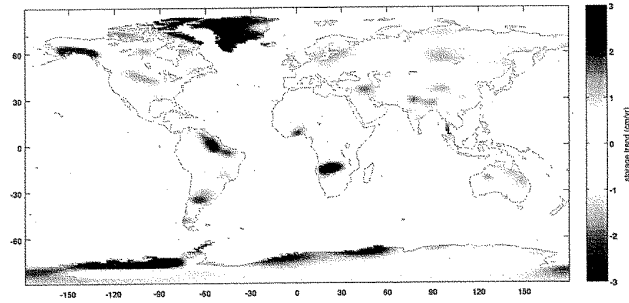


Figure 1. Trends in freshwater availability (cm/yr) from the NASA GRACE mission, 2002-2012. Red and yellow areas indicate losses of freshwater. Blue areas are gaining water. Note that the Southeastern US drought emerges as a long-term (10-yr) trend, implying predictive power when integrated into a forecasting system like NIDIS. Most of the red 'dots' correspond to regions of significant groundwater depletion. Paper in preparation by Famiglietti et al. Data courtesy of Sean Swenson, National Center for Atmospheric Research; and JT Reager, UC Irvine.

The foundation of a modern drought information system that NIDIS could become requires an advanced computer modeling system, such as that described above, that can ingest a range of ground and satellite observations to produce the best possible predictions. It is a daunting challenge and one on which we are making slow and steady progress. To move forward with predictive capabilities in a timely way, a significant increase in funding for 'model-data integration' or 'data assimilation' is required.

Integration with university researchers. The lack of significant university involvement in the NIDIS implementation plan and research report (Pulwarty, 2011) is noted. In particular, the efforts of the Consortium of Universities for the Advancement of Hydrologic Sciences, Inc. (CUAHSI, <http://cuahsi.org>) are consistent with the goals of NIDIS. In particular, CUAHSI's progress on Hydrologic Information Systems (HIS, <http://his.cuahsi.org>) could be leveraged. Its work with the Community Hydrologic Modeling Platform (CHyMP, <http://www.cuahsi.org/chymp.html>) on the development of a national-scale, integrated model with capabilities as describe above, could also help form an important connection to university researchers, and a pipeline for future employees. More generally, the pool of researchers contributing to drought studies and tool development could be greatly expanded by more effective connections to universities.

Pathways for translational science and communication. The time gap between research, for example, in drought forecasting tools, and operational implementation, for example, in NIDIS, is often several years to decades. New mechanisms and additional resources are required to shrink this gap, in particular given that human lives are at risk. In some cases, the case the technology for increasing forecasting lead times – for drought, for floods, for fires – is now available, but the pathway to operational implementation is unclear. Even with effective communication, the human resources at our government labs may not be available to modify current forecast systems.

Beyond the research to operations bridge, better communication of drought issues with the public and with environmental decision makers is also a key to heightened awareness and informed planning. Scientists and engineers are notoriously bad public communicators; nor does the current reward system offer any incentives for improving. A translational body, or a grant program for scientists wishing to engage in public communication, are potential options for raising awareness.

COMMENTS ON DRAFT LEGISLATION

I recommend that language reflecting a commitment to advanced modeling tools be considered. For example, page 2, line 11, use of the term ‘best available’ information, or on page 2, line 13, ‘best possible’ and timely forecasts. The current models are good, but they are far from where they need to be. As described above, an acceleration in hydrological model development is required.

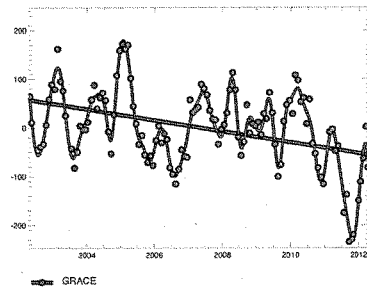
While I do not have access to the total amount of spending on drought research in the United States, the \$13.5 million listed in the draft legislation strikes me as far too small to significantly advance our understanding, prediction and preparedness for drought in a timely manner. If NIDIS is only playing a coordinating role, then \$13.5 million is likely sufficient. However, to address the range of challenges outlined above, a factor of 10 increase will be required to advance modeling capabilities.

CLOSING THOUGHTS

Water issues are rising to the forefront of the American consciousness. The current drought, previous floods, and falling groundwater levels in California, in the High Plains aquifer, and in the Southeastern U. S. have all heightened awareness. Our federal agencies, for example the USGS, the Army Corps, the Environmental Protection Agency, etc., are all working hard and maximizing their available resources. However, water is on trajectory to rival energy in its importance, yet the investment in observations, models, and exploration of the subsurface pales in comparison.

Could we have seen this drought coming? Consider the Texas drought, which has been characterized as having started about 18 months ago. However, data from the NASA GRACE mission shown here, which depict changes in all of the water stored in the central part of the Gulf Coast Drainage (USGS HUC2 region) suggest that the decline has

been going on for much longer – three years or perhaps more. If such data had been integrated into NIDIS, could they have provided an earlier warning and better preparedness (data latency issues notwithstanding)? With the proper level of investment in monitoring and predictive tools, maybe, yes, we could have seen it coming. Note that a similar argument can be made about flooding.

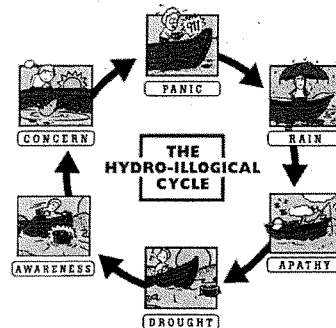


Changes in total water storage (mm/mo) from GRACE for part of Texas. Red dots are monthly changes in water storage as differences from the mean of the 2002-2012 time period shown. Straight line shows decreasing trend for the time period. Data courtesy of Sean Swenson, National Center for Atmospheric Research

The technology for developing advanced models, observations, their integration and their dissemination through information systems currently exists in the United States and around the world. Arguably, our nation requires a technologically-advanced water modeling and information system consistent with our emerging technology-based economy. The vision is in place in the operational and university research communities. Leadership in Congress is what will make

it a reality. We have the potential to be world leaders in characterizing, monitoring and predicting all aspects of the water environment – from forecasting droughts and floods, to science-informed, technology-based long-term sustainable water management. Simultaneously, we can create jobs and protect the health and well-being of our population. The time is ripe and the technology is ready for an advanced, national-scale water modeling framework.

In closing, I suggest that we try to break the ‘Hydro-Illogical Cycle’ of human behavior (<http://drought.unl.edu/Planning/HydroillogicalCycle.aspx>), and become proactive, rather than reactive, about managing one of our nations most precious resources. Note of course, that an investment in drought is an investment in our greater water future.



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http://drought.gov/imageserver/NIDIS/newsletter/Fall_2011_Research_Special_Issue.pdf

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Additional Resources

Last Call at the Oasis, a new water documentary, <http://lastcallattheoasis.com>

Famiglietti, J., 2011, A Drought of Texas-Sized Proportions, <http://blog.ucchm.org/2011/12/11/a-drought-of-texas-sized-proportions-when-praying-for-rain-just-wont-do-the-trick/>

Chairman HALL. And we thank you.

I now recognize our final witness for today, Ms. Patricia Langenfelder for five minutes.

**STATEMENT OF MS. PATRICIA LANGENFELDER,
PRESIDENT, MARYLAND FARM BUREAU**

Ms. LANGENFELDER. Good morning, Mr. Chairman and Members of the Committee. My name is Patricia Langenfelder and my husband is a fifth-generation farmer. And together with our three children, we farm 3,000 acres in Kent County, Maryland, about 80 miles east of here where we grow corn, soybeans, wheat, and barley. We also have a livestock operation. I currently serve as President of the Maryland Farm Bureau, and I also serve on the Board of the American Farm Bureau Federation, the Nation's largest general farm organization, on whose behalf I am speaking today.

And I would like to commend the Chairman and Ranking Member for holding this hearing today on this very important matter. As has been stated a million times already today and on the news and in the media, much of the Nation is currently in the grip of a significant drought that will ultimately touch the lives of every ag producer and consumer in this country. For this reason alone, it is important to have the best, most up-to-date information on the Nation's drought conditions. Farm Bureau strongly supports legislation to reauthorize the National Integrated Drought Information System (NIDIS) and is ready to work with you for swift approval of this legislation.

I would like to give the Committee an idea of the magnitude of the drought now facing farmers. This year's drought is the worst in recent memory. Objective measures of the drought's extent and severity are striking. Around 80 percent of the country is classified as abnormally dry, and more than 60 percent is classified as being in moderate to exceptional drought conditions, the highest percentages in the Drought Monitor data going back to 2000. More than 54 percent of the country's pasture and rangeland is rated as poor or very poor, by far the highest percentage in the available data going back to 1995. Corn crop condition ratings are the worst for this point in the growing season since the devastating drought of 1988.

Dry pasture conditions have begun to force many ranchers to sell their cattle. Given the long biological lags in livestock and poultry production systems, it may take many months, in cases years, for the full effects to be reversed. Ultimately, the reduced production of beef, pork, poultry, eggs, and dairy products will be felt by consumers as higher retail prices.

It is clear what a significant and integral role NIDIS plays in providing important and timely information to farmers and to markets. It provides an unparalleled set of data and graphics on drought conditions in the United States. NIDIS data is available with greater frequency than most other market-related information. Frequently updated NIDIS data and maps and even real-time information on precipitation and temperature allow more informed adjustments to expectations for important new USDA reports like the weekly Crop Progress and the monthly Crop Production reports. This makes it less likely that these reports will catch the

market by surprise, resulting in episodes of extreme price volatility.

In conclusion, Farm Bureau supports the National Integrated Drought Information System Act because it provides the Nation's farmers, ranchers, and markets an effective drought warning system for key indicators of drought conditions and impacts. It is vitally important that Congress reauthorize the National Integrated Drought Information System, and Farm Bureau will do everything we can to assist you in this effort.

We look forward to working with you to reauthorize this important legislation. Thank you and I would be pleased to respond to any questions.

[The prepared statement of Ms. Langenfelter follows:]



**Statement of the
American Farm Bureau Federation**

**TO THE HOUSE COMMITTEE ON SCIENCE, SPACE AND TECHNOLOGY
SUBCOMMITTEE ON ENERGY AND ENVIRONMENT
RE: REAUTHORIZING THE NATIONAL INTEGRATED DROUGHT
INFORMATION SYSTEM**

July 25, 2012

**Presented By:
Patricia Langenfelder
President, Maryland Farm Bureau**

Mr. Chairman and members of the committee, my name is Patricia Langenfelder. My husband, Dutch, is a fifth generation farmer, and together with our three children, we farm 3,000 acres in Kent County, Maryland where we grow corn, soybeans, wheat and barley. We also have a farrow-to-finish swine operation. I currently serve as President of the Maryland Farm Bureau, and I also serve on the board of the American Farm Bureau Federation, the nation's largest general farm organization, on whose behalf I am pleased to testify this morning.

I would like to commend Chairman Hall and Ranking Member Johnson for holding this hearing and inviting me to testify. Much of the nation is currently in the grip of a significant drought that will ultimately touch the lives of every agricultural producer and consumer in this country. For this reason alone, it is important to have the best, most up-to-date information on the nation's drought conditions. Farm Bureau strongly supports legislation to reauthorize the National Integrated Drought Information System (NIDIS) and is ready to work with you for swift approval of your legislation.

At the outset, I would like to give the committee an idea of the magnitude of the drought now facing farmers, particularly in the Midwest, and then I would like to speak to the importance of NIDIS.

While comparisons with prior drought years are imperfect at best, this year's drought is without question the worst in recent memory from a national perspective, and in some areas, unfortunately, it may well rank as the worst drought in decades. Objective measures of the drought's extent and severity are striking. Around 80 percent of the country is classified as abnormally dry, and more than 60 percent is classified as being in moderate to exceptional drought conditions, the highest percentages in the Drought Monitor data going back to 2000. More than 54 percent of the country's pasture and rangeland is rated as poor or very poor, by far the highest percentage in the available data going back to 1995. Corn crop condition ratings are the worst for this point in the growing season since the devastating drought of 1988.

The full economic impact of this drought is difficult to assess at this point because damage is still being done. It appears that corn and soybeans will be the most severely impacted of the major row crops. Nationally, corn production may be reduced by as much as 20 percent compared with early-season expectations. Soybean production may be off by 10 percent to 15 percent. Some parts of the eastern Corn Belt will experience a total loss.

While the effects on corn and soybeans are vivid, the impact is felt downstream as well, where reduced yields and tighter supplies will translate into higher feed costs for livestock and poultry producers. Dry pasture conditions have begun to force many ranchers to sell their cattle. Given the long biological lags in livestock and poultry production systems, it may take many months, in some cases years, for the full effects to be reversed. Ultimately, the reduced production of beef, pork, poultry, eggs and dairy products will be felt by consumers as higher retail prices, potentially reversing a trend of moderating prices for these products, which had been developing over the last few quarters.

Viewed in that context, it is clear what a significant and integral role NIDIS plays in providing important and timely information to farmers and markets. It provides an unparalleled set of data and graphics on drought conditions in the U.S. The NIDIS, by coordinating the data collection, summarization and dissemination efforts of multiple entities, has become an invaluable tool within the agricultural community. This system puts a wealth of relevant weather and climate data at the

fingertips of farmers, market analysts, researchers, extension professionals, crop consultants and anyone else with an interest in U.S. agricultural production. By providing relevant summaries of past data on rainfall and soil moisture, real-time rainfall and temperature data, and forecasts of key drought metrics, NIDIS provides a comprehensive view of drought conditions as they develop, allowing those affected – including farmers and ranchers – to more adequately plan for and respond to a drought's impacts.

As this year's drought has developed, the value of NIDIS has been vividly illustrated. For example, prior to the beginning of summer, NIDIS soil moisture data showed that key corn and soybean producing areas of the country were deficient in moisture and thus vulnerable to the effects of any dry weather that might develop. Later, it was possible to ascertain that in late June, with Midwest corn in its critical pollination phase of development, fully half of the country was experiencing moderate to exceptional drought with extremely high temperatures. Moreover, detailed drought maps were available to show precisely what areas of the country the drought was affecting. This kind of data allows market participants to determine what crops are being most directly impacted by drought and to incorporate that information into market analysis, price projections and risk management planning. In this way, NIDIS information is an extremely useful complement to more familiar Department of Agriculture (USDA) data on acreage, crop progress and production.

Products of NIDIS are also a vital supplement to longstanding and widely-utilized USDA reports in another important respect: NIDIS data is available with greater frequency than most other market-related information. Frequently-updated NIDIS data and maps – and even real-time information on precipitation and temperature – allow more informed adjustments to expectations for important USDA reports, like the weekly *Crop Progress* and monthly *Crop Production* reports. This makes it less likely that these reports will catch the market by surprise, resulting in episodes of extreme price volatility.

In conclusion, we appreciate the hard work of this committee to ensure that America's farmers, ranchers and the market system have the best information available to protect against the vagaries of uncertain weather and provides them the opportunity to continue to produce the safest, most abundant and least expensive food supply in the world. Farm Bureau supports the *National Integrated Drought Information System Act* because it provides the nation's farmers, ranchers and markets an effective drought warning system for key indicators of drought conditions and impacts.

We look forward to working with you toward that goal. It is vitally important that Congress reauthorize the National Integrated Drought Information System, and Farm Bureau will do everything it can to assist you in this effort.

Thank you for considering these views. I would be pleased to respond to any questions from the committee.

**Summary of Testimony of
Patricia Langenfelder
President, Maryland Farm Bureau**

In General

The ongoing drought throughout much of the Midwest underscores the importance of having the best, most up-to-date information on the nation's drought conditions. The American Farm Bureau Federation strongly supports legislation to reauthorize the National Integrated Drought Information System (NIDS).

Conditions of the Drought

The current drought is the worst in recent memory from a national perspective and in some areas may rank as the worst in decades. Roughly 80 percent of the country is classified as abnormally dry, and more than 60 percent is classified as being in moderate to exceptional drought conditions. More than 54 percent of the country's pasture and rangeland is rated as poor or very poor, and corn crop condition ratings are the worst for this point in the growing season since 1988. It appears that corn and soybeans will be the most severely impacted of the major row crops. Corn production may be reduced by as much as 20 percent compared with early-season expectations. Soybean production may be off by 10 percent to 15 percent. Some parts of the eastern Corn Belt will experience a total loss. Within the livestock and poultry sectors, dry pasture conditions have begun to force many ranchers to sell their cattle. Reduced production of beef, pork, poultry, eggs and dairy products will be felt by consumers as higher retail prices.

Importance of NIDIS

NIDIS provides an important set of data and graphics on drought conditions in the U.S. By coordinating the data collection, summarization and dissemination efforts of multiple entities, NIDIS is a valuable tool for the agricultural community. NIDIS helps those most affected, including farmers and ranchers, to more adequately plan for and respond to a drought's impacts. As an example, prior to the beginning of summer, NIDIS soil moisture data showed that key corn and soybean producing areas of the country were deficient in moisture and, thus, vulnerable to the effects of any dry weather that might develop. Later, it was possible to ascertain that in late June, with Midwest corn in pollination, fully half of the country was experiencing moderate to exceptional drought with extremely high temperatures. Moreover, detailed drought maps were available to show precisely what areas of the country the drought was affecting. Such data allows market participants to determine what crops are being most directly impacted by drought and to incorporate that information into market analysis, price projections and risk management planning. In this way, NIDIS information is a useful complement to Department of Agriculture data on acreage, crop progress and production. Products of the NIDIS system are also a vital supplement to longstanding and widely-utilized USDA reports in another important respect: NIDIS data is available with greater frequency than most other market-related information, thus helping to reduce price volatility in the market.

Chairman HALL. And we thank you.

Ms. LANGENFELDER. Thank you.

Chairman HALL. I thank all of you for your testimony.

And I remind Members of the Committee, committee rules limit the questioning to five minutes.

The Chair at this point will open the round of questions, and I recognize myself for five minutes.

I would like to ask you folks who live in the real world, and each of you have touched on cities' rulings, and Mayor, you have had to enforce it, and I have had a touch of that in my hometown I will tell you about later if we have time. But I will ask you all that are on the ground, Mr. Strong, Mayor Ballard, and Ms. Langenfelder, does NIDIS really provide the necessary drought information that you all think we need? And what improvements do you suggest for it? And remember, we just have five minutes so—

Mr. BALLARD. Mr. Chairman, I can speak generally to it. I can't speak about all the details. I would tell you our Homeland Security system and our EOCs rely on it. Certainly, our water utility relies on it also, so it has been a big part of kind of planning, get ahead of it. I think anything that can be added to that that would allow us to look even more into the future with some sort of accuracy I think would be beneficial also, but we certainly use it at the city level, which maybe I am not sure that was the original intent. It might have been more agricultural in nature. But the fact is we do use it at the city level quite a bit and our folks appreciate it.

Chairman HALL. Anyone else want to tie into that one?

Mr. STRONG. And I would just echo what the Mayor said as well. I think that NIDIS has definitely improved in integrating the data and information in one place that we can use to make decisions going forward. The Holy Grail, though, will be more accurate, longer-term predictions of drought into the future so that we can actually make some mitigation measures helpful a season or even a year in advance.

Ms. LANGENFELDER. And I would echo the same and I just think that it is important that the agricultural community be aware. Early warning would be wonderful so that, you know, it helps when you are doing planting preparations to know that, gee, there is a drought coming. When you planted earlier this year, we did not know that. Some areas of the country did not know that, did not realize it, and so therefore a lot of money and expenditures was put into the ground and there was—there is no crop coming back out.

Chairman HALL. Well, I thank you. And you have given us a lot of practical information. You know what you are talking about, for sure.

I just thank all of you and it is still that five minute speech I gave to begin and I should have just said we need to know more about when a drought is going to hit us and then tell them—give some reaction to it a little bit quicker. That is what this hearing is really all about.

And Dr. Pulwarty, how good is the current drought forecast issued by NIDIS and how accurate are the forecasts for a month, three months, or a year, 30 days, or 20 minutes or whatever?

Dr. PULWARTY. Certainly, on the seasonal, 30-day to 90-day, when there are conditions such as El Nino and La Nina events in the Pacific, the forecasts are fairly reliable. In fact, as early as summer of 2010 because of the La Nina event the Climate Prediction Center at NOAA was able to say that the likelihood of drought development in the southern States was pretty high. So from the standpoint of reliability, the seasonal forecasts are fairly reliable.

Moving out to the year, what ends up creating issues related to predictability and the reliability forecast has to do with the background variability on the ten-year timescale. So from our standpoint, linking the seasonal forecasts and the reliability of those forecasts to what is happening in the background, the Atlantic multi-decadal oscillation, the Pacific decadal, natural variability, the changes to reliability of the forecast is an area of research and in fact an area of applications.

Chairman HALL. I am very close to the end of my questions so I will recognize Mrs. Johnson for her five minute questions.

Ms. JOHNSON. Thank you very much, Mr. Chairman.

NOAA recently released the 2011 State of Climate report detailing global climate indicators in notable weather events. It included details on a number of extreme weather events such as the deadly tornado outbreaks in the United States and the extreme drought in Texas. Also released was an article published in the Bulletin of the American Meteorological Society that examines the potential linkages between climate change and the extreme weather events of 2011 such as a drought.

I know that many of my colleagues on the other side like NIDIS, but for the past couple of years, they have done everything possible to block investments in climate change research and provided climate services more efficiently. I think the only way for us to know how to mitigate and respond to these events is to understand what is happening and the extent to which climate change is contributing to the severity and duration in addition to coordinating monitoring activities or other coordinated information services and research needed to understand global warnings potential role in driving the severity and frequency of such extreme weather events.

I would like to hear from you, Mr. Strong, as well as Dr. Famiglietti on your comments on this.

Mr. STRONG. Well, he certainly is the scientist so I am sure he has a lot to say about that. I will just reiterate what I said earlier. I think long-term predictions of climate and its variability over 10-, 20-, 30-, 40-, 50-year timescales would be great, but as a practical matter, what we are more interested in at this moment is can we get to a year forecast of drought that will be something that we can take to the bank. That to us is really, as a practical matter, more important than those longer-term forecasts, even though longer-term forecasts certainly have value. I think the add is you got to walk before you can run is applicable here and so getting those shorter-term, more accurate drought predictions in place would certainly help us do our jobs much easier.

Dr. FAMIGLIETTI. Famiglietti. It is a silent "g".

The links between climate change and increasing extremes like flooding and drought are becoming much better established. They

have been predicted by the IPCC for a number of years now and more research is being conducted that is bearing that out.

I can just mention some of our own research using the GRACE mission, which has only been operating for ten years, but in that ten-year time period—and that is the slide that I showed behind me that showed the trends—there is a corresponding map that goes with that trend map that I showed that I don't have in my testimony that actually shows the water cycle and where it is strengthening. And by strengthening, we mean more precipitation and more evaporation and therefore more storms and more droughts.

So we are working on quantifying the frequency and the intensity of flooding and drought. And even in just a ten-year time period, we are seeing some increases and at least figuring out how to quantify them.

Ms. JOHNSON. Thank you.

How does NIDIS aid in water planning and management during times of drought? I know that the immediate information makes a difference but as climate prevention for future droughts to aid and also early warning, shortness of time, but also having time to plan when you can predict longer times, could you comment on that, Dr. Pulwarty?

Dr. PULWARTY. I can. Thank you. I appreciate Dr. Famiglietti's comments and his name. Usually mine is the most difficult to pronounce.

So what we have been saying is from the standpoint of the information we have pulled together is in the midst of the development of droughts, while the onset is very critical, as we have seen in Texas and elsewhere, it is the development of drought intensification that begins to matter, when the reservoirs are lower, when food prices for livestock begin to go up. One of the things that we do is very much from the onset before any of that happens, ensure that the way the federal drought plans and the state plans are developed, people develop them on their own—it is their role to do so—we ensure that the information that we are going to be able to provide can be used more effectively up front by those plans.

And so from that standpoint, we try not to just, you know, show up when a drought is happening but instead work from the research standpoint on ensuring that the plans can take full advantage of the soil moisture monitoring, of the forecasts, and so on.

Where planning begins to take place from our standpoint is in improving the local assimilation of data that informs the national product such as the Drought Monitor. The drought plans and water plans in many areas are not as well linked, and part of our role is to make sure that they both receive the same data and information.

From a water resources management standpoint, we make certain or try to make certain in the areas that we have been able to put early warning systems the way the entry points for information are in those plans are identified long up front so that we are not trying to find them during a drought event.

Ms. JOHNSON. Thank you very much. I yield.

Chairman HALL. I thank you and now recognize Congressman Smith, the gentleman from Texas, for five minutes.

Mr. SMITH. Thank you, Mr. Chairman. And Mr. Chairman, I want to say that I concur with the comments you made about the effective drought in Texas. All the friends I have who engage in dry land farming in south Texas have now lost their crops two years in a row because of a lack of rain. And it literally looks like a desert. I was there last weekend.

First of all, Dr. Pulwarty, I would like to send a compliment your way. The Lower Colorado River Authority in Texas that you are familiar with has told me that they very much appreciate your willingness to disseminate information to them, to the landowners, to the farmers, to the policymakers as well, and they appreciate that good communication.

I would like to direct, though, my questions to the other panelists. Dr. Pulwarty, I expect you to defend the presence of budgets so I am not going to ask you budget questions. But I would like to ask the other panelists if they feel that in the current budget proposal NIDIS has received a high enough priority or should there have been greater sense of urgency and a greater priority given to what NIDIS does? And Mayor Ballard, I guess we will start with you.

Mr. BALLARD. That is a great question. I am not familiar with all that goes on in this city, as you—not all the time. But I would suggest to you, sir, that anything that can mitigate the costs, the losses if you will, of the last few months across the Nation and, as you mentioned, last year also, needs to be upgraded in a priority listing because it saves all of us. It not only keeps people working but it also increases the tax base for municipalities, for States, and for the Federal Government eventually. So, you know, this could be the penny wise in this instance.

Mr. SMITH. Thank you.

Mr. Strong, do you feel NIDIS gets a high enough priority in the budget proposal?

Mr. STRONG. Well, I don't specific budget proposal, but typically, I would say that given the billions of dollars and number of lives that are stake, that it certainly deserves heightened importance both in the budget and just in terms of attention. I know Dr. Famiglietti can talk more specifically about the shortfalls and gaps and did in his testimony, so certainly additional funds and resources would help. But given the billions of taxpayer dollars that are going to go out to address this issue, being able to avoid that by having some proactive measures in place using drought outlooks, for example, would be extremely helpful.

Mr. SMITH. Dr. Famiglietti?

Dr. FAMIGLIETTI. So by priority do you mean higher amount?

Mr. SMITH. That and more emphasis perhaps, higher priority.

Dr. FAMIGLIETTI. Okay. So I make a comment in my written testimony that if NIDIS is to continue to play mostly a coordinating role, then I think the amount of money that has been allocated is sufficient. But to really do a great job, you know, what underlies what Dr. Pulwarty is trying to accomplish in the models. And so, you know, I made the point that I think the models are far from where they need to be.

Mr. SMITH. Okay.

Dr. FAMIGLIETTI. And so that is a much greater investment.

Mr. SMITH. Great. Mrs. Langenfelder?

Ms. LANGENFELDER. Well, you are talking to someone who doesn't know very much about how much it is budgeted for, so I would just say that it is an important factor in reporting, but I am not familiar with that and I would have to apologize that I don't have a very good answer.

Mr. SMITH. Okay. I was going to suggest the Farm Bureau could always use more in that area, but—

Ms. LANGENFELDER. Oh, we can always use every—lots more of everything.

Mr. SMITH. Okay. Last quick question here. Let me start again with the four panelists who just answered those questions. Is there anything more that NIDIS should be doing? You know, what other practical improvements can be made in their programs.

Mr. BALLARD. Well, it is easy to state the obvious. I think for most folks, I always like more research, no question about that, but the longer and more accurate need to make these forecasts I think is going to have the most impact.

Mr. SMITH. The number one priority. Okay.

Mr. BALLARD. Sure.

Mr. SMITH. Mr. Strong?

Mr. STRONG. Number one priority for us as well. If we could get early warning systems, especially for Oklahoma, in place right away, that would be great.

Dr. FAMIGLIETTI. I think education and awareness amongst the general public is critical.

Mr. SMITH. Okay. And Ms. Langenfelder?

Ms. LANGENFELDER. And the early warning for the agricultural community.

Mr. SMITH. Okay. Okay. Thank you all for your answers.

And Mr. Chairman, I can't help but make a plug here because one of the great spinoffs of the Space Program has in fact been better weather forecasting. So that is an example where what you are talking about in our Space Program being interconnected and that is one of the great spinoffs that we have had. Thank you, Mr. Chairman.

Chairman HALL. And I thank you.

Ms. Lofgren from California for five minutes.

Ms. LOFGREN. Thank you, Mr. Chairman. And I—this is obviously a very timely hearing and I think I am hearing general consensus from the panel that when our Chairman and then-colleague Mark Udall put together this scheme, it actually has resulted in a good thing and it has been helpful, NIDIS has. And the question, I guess, before us is can we make it even more useful to the country? Dr. Famiglietti, I was struck by your chart that you showed and is also in your testimony about trends in fresh water availability, what is the reddest spot on that map are the Poles, massive loss of ice at both Poles, which is—brings to the forefront the question that so many Americans have, which is what is the role on the changing climate to the weather that we are experiencing?

If we are going to move beyond a mere coordinating role for NIDIS, as you suggest, how would we integrate the climate change data that is being collected throughout the world into this mission that is NIDIS? I mean that is a huge challenge.

Dr. FAMIGLIETTI. That is right. And so we are actually blessed in this country to have a great set of observations and your—on the ground and so your support in continuing those and increasing some of those will be greatly appreciated. But I think the key thing is some of these satellite missions like the ones that I have mentioned—you mentioned the chart from the GRACE mission—and there is a future satellite mission—NASA mission called SMAP, Soil Moisture and—it is a soil moisture mission that will measure the wetness of soils. It will be great for agriculture. It will be great for a flood prediction. And the SWOT mission, which I mentioned, on tracking surface water storage changes over land.

So I think one of the key frontiers for predictive modeling of the sort that underlies NIDIS is to be able to tightly integrate that satellite information with our models. And that is a huge task because the sensors make measurements at different times, different spatial resolutions, and then if you want to integrate the ground base measurements, this is a very difficult problem but essential.

Ms. LOFGREN. As a fellow Californian—and welcome to the Committee—I am wondering if you could discuss how NIDIS might be used to—in assessing complex water planning—

Dr. FAMIGLIETTI. Sure.

Ms. LOFGREN. —that goes on—

Dr. FAMIGLIETTI. Sure.

Ms. LOFGREN. —for example, as you know, our Governor has just made a proposal relative to the Sacramento Delta. It is pretty controversial—

Dr. FAMIGLIETTI. Um-hum.

Ms. LOFGREN. —given the amount of water that would be—

Dr. FAMIGLIETTI. Right.

Ms. LOFGREN. —removed. Implicit in that discussion is not just the water quality issue—

Dr. FAMIGLIETTI. Right.

Ms. LOFGREN. —but what is going to happen in terms of water flow, the impact on the ecosystem of the Bay, of the San Francisco Bay as well as the Delta, the collapse of the—

Dr. FAMIGLIETTI. Right.

Ms. LOFGREN. —snowpack? Can this data be used not just for the prediction of a drought for planning because that is obviously important but for a broader assessment of how we are going to cope?

Dr. FAMIGLIETTI. Right. Yeah, so absolutely. And this is exactly what I am talking about. So by this tight integration of, say, in California high resolution computer models of the water cycle for California integrated with the space-based and ground-based measurements would give us a very best-available picture of what is happening with the snowpack, what is happening with the streamflow, what is happening with the soil moisture, and what is happening with the groundwater. Once we have that, then we can give that to the Department of Water Resources, to the Governor's office and say this is what we see. And we can also do some predictions in the future about planning options based on this best-available science.

Ms. LOFGREN. And finally, in terms of planning options—and you may not be able to answer this question—but the pace of climate

change has exceeded all the computer models that I ever saw. I mean it is in the worst-case analysis——

Dr. FAMIGLIETTI. Um-hum.

Ms. LOFGREN. —that I saw back in '95 when the Brits did the first modeling——

Dr. FAMIGLIETTI. Right.

Ms. LOFGREN. How far out, given that the reality has exceeded the worst-case prediction on climate change, do you think we could predict using the models that you are talking about?

Dr. FAMIGLIETTI. So it is very difficult question. And I think once you go past, you know, a few decades, the uncertainty grows, of course, but you can see general trends and you can think about options and you can plan out a range of options. It is just that the uncertainty gets greater because it is further out in the future.

There is a difference between, say, forecasting like what is going to happen in the next week or the next month and long-term planning. So, you know, with the forecasting, very similar to what Dr. Pulwarty is working on, we can probably go out a few months, a season. Once you get to a year, there is not much value. But from a planning and sort of future perspective, thinking about the possibilities of what will happen with, say, water resources in California or the western United States, we can go out a few decades and really start to think about what might happen and start to plan for that.

Ms. LOFGREN. Thank you, Mr. Chairman. My time has expired.

Chairman HALL. Thank you.

And I recognize Dr. Harris, the gentleman from Maryland, for five minutes.

Mr. HARRIS. Thank you very much, Mr. Chairman.

And, you know, with regards to predicting the outcome or decades out and the IPCC report, let's just remember that the 2012 IPCC report on managing the risks of a string of events and disasters to advanced climate change mitigation concluded that "there is low confidence in the attribution of changes in droughts at the level of single regions due to inconsistent or insufficient evidence." And might I add, maybe we just need more evidence. But they went on to say in that quote, "North America there is medium confidence that there has been an overall slight tendency toward less dryness." So just in case, you know, some Members or some folks want to say that there is some definite connection and that this—climate change has some definite longstanding effects, I mean this is the IPCC. This is not an anti-environmental group coming out saying there is a medium confidence that there has been an overall slight tendency toward less dryness. I can tell you I can't see more hedging than that in the wording.

But anyway, Ms. Langenfelter, let me ask you. In your testimony you spoke to the adverse impacts drought can obviously have on crops and farmlands and how it will affect the price of corn, feedstock, and related agricultural commodities. Now, I will tell you, as you are well aware, corn hit a—went over \$8 a bushel I think. If it wasn't earlier this week, it was late last week. Record high—and we know the price of gas just went up.

Affordability is becoming a problem for more Americans, even those who have jobs. I mean they say, look, things are not afford-

able. The price of grain affects not only directly the price of food but in terms of livestock, drought affects it in two ways. One, it raises the price of grain. The other is that you lose livestock, I mean the owners of livestock that thin their herds or they just don't raise as much either because it is no longer profitable to raise the livestock because of food—is that correct? I mean is that what we are going to see in the next few months if the price of grain commodities directly in food—directly and then livestock indirectly are going to increase, become even less affordable for Americans?

Ms. LANGENFELDER. That is anticipated that will happen only because the price of feed gets so extremely high that the farmers, ranchers cut back on their livestock numbers. They will market them maybe in the short term. There will be a downturn in some of the pricing for some of the meats if you are talking about the meat specifically. But in the long-term if they thin the herds out, then in order to rebuild it takes—for cattle it takes years for it to reverse and poultry, it is a little quicker turnaround on that, and hogs are kind of in the middle.

So yeah, it could affect it in the long-term, and that is an unfortunate outcome of a drought because we lose the crop—the cash crop of the grain and then the farmers who are feeding can't afford it so then they cut back on their herds and so there is less meat out there.

Mr. HARRIS. And we know in fact that that is—we know—and the gentleman from Texas brought it up and the Chairman I am sure is well aware that, you know, this is what has happened to the price of—certainly the price of beef. I mean I, you know, I was in the store over the weekend—we all go to the store over the weekend and it is different over the last couple years because the American herds have been thinned.

Now, Dr. Pulwarty, let me ask you because, you know, NIDIS, hopefully, if we could predict with some confidence, even in the short-term, even a seasonal term, that we knew what sections—and we know where we are growing the grain so we could make a guess at some of the prices of grain—and the reason why this important is because there was an article today in the—this morning in the Wall Street Journal reporting that one of the largest hog producers in the United States is going to buy its grain now from Brazil. Okay. So we are basically the grain exporters to the world, now we are going to import grain because the price is so high.

So what are the folks over at NOAA doing to talk to the folks at EPA to say, wait a minute. If we can predict that we are going to have a drought and that the price of corn may well go over \$8 and in fact what we are going to do is we are going to drive some of our production over—some of our acquisition of grain overseas, we are going to have the price of gasoline go up and fuel go up because of the renewable fuel standard, we are going to have the price of beef go up and chicken go up and cereal—breakfast cereal go up, have you been talking to the folks at EPA to say wait a minute. Why don't we talk—why doesn't the Administration talk about controlling the affordability of things like gas and food by thinking of maybe freezing the renewable fuel standard? Because this is something—could you have predicted this 2 months ago? I

mean could you have predicted the fact that it looked like grain prices were going to rise a couple of months ago?

Dr. PULWARTY. So to answer the question, the main groups that we work with from that standpoint is in fact USDA. And we look to other parts of the world for where droughts like these are happening and where purchasing can be much less from our standpoint. In terms of the near future, we certainly say something about the persistence of drought in the Midwest and the upper Midwest and maybe the release of drought conditions in the Southeast. From that standpoint, our major collaborator has been the water agencies such as the Corps of Engineers, Reclamation, and the USDA but not with EPA other than on low-flow water quality issues during drought.

Mr. HARRIS. And if I might just take 10 more seconds, Mr. Chairman.

Why not the EPA since the renewable fuel standard is what is—combined with the drought is what causes corn to be at near \$8 a bushel right now?

Dr. PULWARTY. So from our standpoint the major role of NIDIS is to produce an information system that allows people to have the accessible information they need to make their decisions. And so we do not make recommendations about what they should be doing.

Mr. HARRIS. Oh. Thank you, Mr. Chairman. I hope to send something over to the EPA. Thanks.

Chairman HALL. All right, thank you.

The Chair recognizes Mr. McNerney, the gentleman from California.

Mr. MCNERNEY. Well, thank you, Mr. Chairman, for holding this hearing. I think it is an important—it is important information.

In my mind, it is critical that programs like the NIDIS be in place to provide critical information and support, and I am really delighted to see many of my Republican colleagues agree on this.

Mr. Famiglietti, can you kind of give us an idea of how accurate programs such as NIDIS can be in providing drought early warning?

Dr. FAMIGLIETTI. Yes. NIDIS, you know, what underlies NIDIS are weather prediction models. So we really won't be doing that much better with drought prediction than we will on our short- and medium-range weather predictions. So in that sense, the problems that underlie or the—you know, the ways to increase or improve our drought reliability forecasts are the same that we need to do to improve our weather forecasts and our hydrological forecasts. And so I think that we can realize great decreases in uncertainty mainly with integrated available measurements both on the ground and from satellites into our models. So I think that we could get our uncertainties down—you know, at some point we will be moving out to—from—having much more reliability in our seasonal to annual forecasts, sort of the next horizon.

Mr. MCNERNEY. Well, I think you mentioned needing more realistic modeling—

Dr. FAMIGLIETTI. Um-hum.

Mr. MCNERNEY. —and a national water model. Now, that includes data from NOAA's geosynchronous satellites—

Dr. FAMIGLIETTI. Sure.

Mr. MCNERNEY. —as the polar systems, is that right?

Dr. FAMIGLIETTI. That is right. Right.

Mr. MCNERNEY. What else do we need—

Dr. FAMIGLIETTI. Right.

Mr. MCNERNEY. —besides those additional pieces of—

Dr. FAMIGLIETTI. Okay. So some of the key things that are missing—so—and this is an important question because it draws the link between what Dr. Pulwarty is talking about, which is sort of predicting the drought and the work that we do in our research group, which is sort of understanding what happens to the water. So many people don't realize that we do not have a national scale water model that can help us predict streamflow, you know, in any of the major rivers of the United States. We don't have it. We don't have a national model that can tell us how much water is in the Ogallala Aquifer in the coastal plains or in the central valley. We don't have that. So that is something that is absolutely essential to take the step from the occurrence of drought to knowing how much water is available.

Mr. MCNERNEY. So one of the things you said that was kind of striking is that we can lead the world in long-term water management understanding. How would we get there?

Dr. FAMIGLIETTI. So I think with help from you and encouraging more research funding through our funding agencies like NASA and the National Science Foundation and NOAA, but also I think that there is a lot of potential benefit in public-private partnerships. There is a lot of resources available there and there is a lot of technology. So I think the time is right for those sorts of partnerships because we could really surge ahead.

Mr. MCNERNEY. Thank you. I know NOAA was hurt by the cutoff of the Polar Satellite System, and I would expect that would impact this program as well, the NIDIS program as well.

Dr. FAMIGLIETTI. Right. So I am not—I am actually not familiar with that satellite—with those satellites that you are talking about.

Mr. MCNERNEY. Mr. Pulwarty, you are familiar with that. Could you address that a little bit?

Dr. PULWARTY. The addition of the information that provides shorter-term risk analyses that some of those satellites provided helps us understand when a drought might end from the standpoint of whether or not you get heavy rainfall events, and that was one of the contributions of that satellite.

Mr. MCNERNEY. Well, I mean it seems that what you are talking about needs consistent, reliable research data and information, and cutting off programs like that is going to set us back whenever it happens. These programs—these satellite programs, they have long-term, long-lead items that take six months, nine months, years and companies need to plan ahead for those purchases. So what you guys need in my opinion is just a reliable budget so you will know what to plan for and how to use the resources that are available, not just additional resources but consistency of resources.

Dr. FAMIGLIETTI. That is right. Mostly, we operate on three to five year at best—average three-year funding cycle, at best a five-year funding cycle and it is really tough to get any momentum.

Mr. MCNERNEY. Thank you, Mr. Chairman. I will yield back.

Chairman HALL. All right. I thank you.

And the Chair recognizes Mr. Benishek, gentleman from Michigan, for five minutes.

Mr. BENISHEK. Thank you, Mr. Chairman.

Thanks for being here this morning. It was great to hear from you all. My question is for Mrs. Langenfelder. As you may know, I represent northern Michigan where agriculture is a critical part of our economy. We have fruit orchards, dairy farms, and a lot of business and industry that support those farmers. And I am impressed with the results of the drought-related research and the data that NIDIS has been able to produce, but I am wondering how individual farmers can best use this data? I am a friend of farmers. I want to support farmers in any way I can in my district, but do you feel that the farmers are up to speed on this? Do they have the technology, the information, the education they need to implement this data or use it effectively?

Ms. LANGENFELDER. Well, the data would be obviously what we are interested in is the weather and also the soil moisture content and things like that were discussed earlier. And, yes, most farmers, if they are going to stay in business, they try to stay up with technology and information and do learn about that—those kind of things that they need to use and utilize in order to stay in business. I mean—

Mr. BENISHEK. On your farm you access this site weekly or—

Ms. LANGENFELDER. No.

Mr. BENISHEK. —I mean how do you get your information on this personally?

Ms. LANGENFELDER. Well, you know, the internet and all the things come on Smartphones and all that. And my son and my—my son and daughters are quite agile with those, unlike their parents.

Mr. BENISHEK. But you don't access it yourself, then?

Ms. LANGENFELDER. Personally, no.

Mr. BENISHEK. Well, that is the kind of thing I am wondering about, you know, if there has been enough education of farmers that they have, you know, day-to-day access, do they know how to do it? Is the Farm Bureau talking to those guys?

Ms. LANGENFELDER. Certainly, there is education. The Extension helps you quite a bit with—in education to the farmers. And we get a lot of publications and you get information and weekly or monthly reports from Soil Conservation Service and you get it from Extension all the time. I mean we get—so there is updated information out there for farmers, and if they are internet savvy, they certainly are on top of it.

Mr. BENISHEK. Dr. Pulwarty, do you have a comment? You kind of look like you wanted to chime in.

Dr. PULWARTY. Yes, thanks for the question.

One of the major contributions we have tried to make is by working with the National Drought Mitigation Center, with the Extension Services, with state climatologists on helping communities and local folks become more conversant with what we put on the web, and more critically, how to use that information.

To say that we have national coverage in really working with folks at that level is not true, but what we have, a set of programs

with the Mitigation Center, with Extension Services on creating what we call drought-ready communities whose major role is to be able to access and get guidance on the use of the information that we put on the website.

Mr. BENISHEK. All right. Thanks.

Mr. Strong, what lessons has Oklahoma learned that you could share with the Committee? And explain your work to support farmers such as, what methods have been more successful than others? Is there information that could have been provided more timely? Or are there specific programs about—that are within this that are especially valuable?

Mr. STRONG. Sure. I think one of the great successes of NIDIS has been the integration of—and coordination with other agencies and gathering that data. I think that the program, I would say, is still in its infancy after only 5 or six years but already we have seen great gains in that regard. So when we talk about how can farmers actually access this information, the weathermen, for example, in a State—in an agriculture State like Oklahoma are rock stars. Those are the guys that most people pay attention to when they watch the nightly news. But now, folks are starting to learn and the farmers and producers on the ground in Oklahoma are starting to learn they can access even more information related to drought through the Drought Portal, which has been set up, through integration of NOAA and the scientists involved with land grant universities. That sort of thing is helping to get the word out and helping our farmers and producers be able to get better access to that data information.

I think there is still a lot of gains to be made in that regard as well, and hopefully, an additional six years or more NIDIS will help us be able to get that valuable information out to our farmers and producers so they can make sound decisions and investments a season in advance if not a year in advance about what to plant and that sort of thing.

Mr. BENISHEK. Well, thank you very much. It looks like I am out of time but I want to see this program continue as well. Thanks.

Chairman HALL. I thank the gentleman.

Chair now recognizes the gentlelady from Oregon, Ms. Bonamici, for five minutes.

Ms. BONAMICI. Thank you very much, Mr. Chairman.

To begin with, thank you all for coming here to testify today.

The district I represent, the First Congressional District in Oregon, is home to some diverse agricultural interests, and while we may not today be facing the same drought conditions that are being experienced in places like the Midwest and other places of the country, I want to assure you that we are certainly interested in the conversation that we are having here today.

I would like to take some of my time to talk about NIDIS and the Cooperative Extension Services. The Extension Services play a vital role in my community and across the country by linking the agricultural research and the communities and farmers that rely on the local extensions to get information. The thousands of extension offices across the country bring the expertise of the land grant colleges to their communities and surrounding regions, and the

data that NIDIS provides is used by extension professionals as they help my constituents plan for weather conditions.

So in Oregon, we have a prevalence of specialty crops, things like blueberries, hazelnuts, making Extension Services even more important. Some of the—for example, the wheat growers may go directly to the Oregon Wheat Commission to learn about the NIDIS predictions but the specialty crop growers often go directly to the Extension Services for information. And some of the extension offices even have specific information about the specific crops for the growers in the district.

So my constituents have expressed some concern about the proposed reductions to the extension services in the fiscal year 2013 appropriations for the Department of Agriculture. And although you may not know the details of those proposed reductions, I wondered, especially Dr. Pulwarty, one of the topics you discuss is the collaboration with Extension Services as you work to develop a network of state-based drought information coordinators. And I know, Ms. Langenfelder, you just brought that up, and Mr. Strong, the importance of Extension Services and the land grant universities. So considering this, can you describe how reductions in the budget for programs like extension services would impact drought preparedness in response to agricultural communities across the country?

Dr. PULWARTY. Relative to Oregon itself, one of the things that NIDIS helps support through drought research is the Oregon Climate Center out of Oregon State University. And in addition, a big part of their role is to interact with the network of people who provide information to the Extension Services. Any capability we have to get down to the level at which droughts are actually declared, at the county level, increases the value of the information to the American people.

Ms. BONAMICI. Thank you.

Ms. LANGENFELDER, you are nodding your head.

Ms. LANGENFELDER. Well, I am just in agreement. And it is very important to keep the Extension Services available. It is integral to the success of agriculture in most—across the country really.

Ms. BONAMICI. Thank you. Thank you very much.

Mr. Strong and Dr. Famiglietti, I wanted to ask you, you both mentioned the “hydro-illogical cycle,” human behavior to ignore drought until water resources are depleted and the situation is dire. So how can we break that cycle? What can we do about that?

Mr. STRONG. Education and outreach is the key there. You talked about Extension Service, land grant universities I mentioned, that sort of thing. That is why they are also critical in that regard, helping people understand that this is not just something that is going to go away and never come back. This is something that happens in Oklahoma every year and how do we best prepare for it? So I think that is key as far as I am concerned.

Dr. FAMIGLIETTI. First of all, I wanted to say that you had me at blueberries and hazelnuts.

We think about this a fair amount and one of the things that we have come to in our research group is that people need to understand where their water is coming from. And if they understand where their water is coming from and what is happening to that

particular source, then they will understand the long-term available. So in Southern California, we have water from the Sierras and the snowpack is decreasing, and we use groundwater, and we import water from the Colorado River Basin, where the snowpack is also decreasing. So that sort of awareness I think will really help people understand for long-term prognosis.

Ms. BONAMICI. Thank you very much. And we also have some very fine vineyards in my district which I would be remiss to not mention.

So thank you, Mr. Chair. I yield back.

Chairman HALL. All right. The Chair recognizes the gentleman from New York, Mr. Tonko, for five minutes.

Mr. TONKO. Thank you, Mr. Chair. And thank you for the hearing. I think it is so timely. And to the witnesses, the input has been very valuable.

Mr. Strong mentioned Oklahoma's work with one of NOAA's Regional Integrated Sciences and Assessments groups. Are these regional groups addressing options for adaptation? And if so, is this a role that should be strengthened?

Mr. STRONG. I—you know, we have a relatively new RISA in Oklahoma. Certainly, I think that is part of the goal there, certainly better integration with our stakeholders in the Oklahoma, the water users, farmers, producers, energy producers, and that sort of thing to make sure that data and information that is relevant to their line of work is getting to them and is being collected. So making that connection certainly is a benefit of the RISAs. And adaptation I believe is certainly a function of those centers as well. Again, it is going to hinge on being able to make better, more accurate predictions going forward as to whether or not a lot of that information is valuable. But it certainly was helpful to us in our recently completed long-range water planning process as well, looking at the different potential scenarios, whether it is warmer, moister, hotter, drier, that sort of thing.

Mr. TONKO. And is there a way to strengthen the capability through the NIDIS program?

Mr. STRONG. I am sure there is because I think the NIDIS program does provide that fundamental information that is valuable to that long-term prediction and the biggest benefit I believe is integrating all of the other data-collection efforts together into one place.

Mr. TONKO. Dr. Pulwarty, I think you wanted to address the whole capability.

Dr. PULWARTY. Yeah, thank you. There are 11 of those centers around the country, and as Mr. Strong was describing, their major role is really to understand how the cities, the States, and the regions that they are in are developing their planning, preparedness, and adaptation, and then to ensure that the best available scientific information is provided to them. From that standpoint, we have seen many successes around the country on increasing the capabilities of municipal, industry, and State, and what we tend to do through the Coping with Drought research program is ensure that those RISAs have the funds to work with the network of information users.

Mr. TONKO. Thank you.

There was also mentioned made of—I believe it was by Mr. Strong—of NOAA's River Forecast Centers and the Streamgage Network operated by the USGS in partnership with the States. As you are all aware, I am assuming, the USGS network is struggling and we have lost some gages. There has been talk of the satellites here this morning but the gages is part of that network with real-time measurement, this network, especially for gages where we have long-term measurements, are crucial to understanding our water budget and getting better predictions for droughts and floods. I wonder if you could address that, any of you on the panel, please. Dr. Famiglietti?

Dr. FAMIGLIETTI. So you raised a critical issue and so the number of streamgages in the United States is in decline. It is also in decline globally. The satellites will help us understand some things but one of the things that they really won't be able to do in a great way is tell us what the discharge is at a certain point on a river basin. It will be sort of a prediction but it won't be a direct observation. So there is no substitute for a robust ground-based network of streamgages, not only streamgages but more monitoring, ground-water wells, and even the USDA is now measuring soil moisture with its SCAN site. So those are invaluable. They need your continued support. And the USGS could certainly use your help.

Mr. TONKO. Thank you.

Anyone else?

Mr. STRONG. I might just add that because NIDIS is not a bureaucracy in and of itself but it is heavily dependent on coordination with all of the other agencies that collect invaluable information like streamgaging information from USGS, it is important to make sure that not only adequate funding is provided for NIDIS but adequate funding is provided for all of these other streamgaging programs, reservoir monitoring at the Corps of Engineers Bureau of Reclamation, SNOwpack, SNOTEL monitoring at NRCS. All of those are extremely valuable and need support as well.

Mr. TONKO. Thank you.

And Dr. Pulwarty?

Dr. PULWARTY. Thank you. To add to the chorus, there is nothing we can do without these enabling capabilities. The seasonal forecast, even longer projections are important. The satellite data is important but there is no substitute for local monitoring and understanding people's local situation.

Mr. TONKO. Thank you so much.

And Mr. Chair, I think I just went over my time. Thank you.

Chairman HALL. In pretty good time.

You know, today's baseball teams all have what they call a closer. You know, it is a good pitcher that comes in there at the 8th or 9th inning, and we have got one of the best closers in this Congress. It is Congressman Rohrabacher from California. I yield him five minutes. And then we have a Democratic closer down at the end, too. We don't want to forget her.

Mr. ROHRABACHER. I thought you had forgotten about her.

Chairman HALL. All right. You are recognized, Mr. Rohrabacher.

Mr. ROHRABACHER. I think what the Chairman is referring to is when I start, everyone else leaves. So I apologize for having to

come back and forth between hearings. Mr. Chairman, there was a hearing in the Foreign Affairs Committee on human rights abuses by the Chinese government, and I feel that it is very important for us to understand the economic relationship we have with the world's worst human rights abusers.

But what is important is for us to stand up for our values. It is also important for us to make sure that we have the water and the energy necessary for ordinary people in our own country to live decent lives and enjoy the freedom that is our heritage as Americans.

We have a lot of problem with water in California even. There is a problem that we understand is affecting a huge chunk of our most important industry, which is agriculture. And we are dismayed, let me just note, Mr. Chairman, that we are dismayed in California that huge amounts of water are being permitted to go off of the high Sierras, which is our water source, and dumped into the ocean in the name of saving the delta Smelt, a little fish about—you know, it is not even big enough to use for bait—and that type of nonsense has got to stop, too. But I agree with many of the points that have been made here today.

Let me ask about the last point on monitoring, we have gotten in big trouble here in the last 20 years looking at computer models on weather and climate, big trouble with that. What we do need to make sure is that we are basing our decisions not on computer models but on actual gauging and measuring. And the last point that was just made here in the Committee is vitally important is that computer models can get all screwed up by whoever is putting information into the computer because they can get out of the computer whatever they want. But if we actually have the data, the hard data from instruments on the ground in measuring these water resources that we have, that puts us in a much more effective way of handling droughts and other natural challenges.

I take it from the testimony that we have had many droughts. There are many cycles. My family grew up in North Dakota in the 1930s and I grew up with all of these tales about the great Dust Bowl and how they couldn't even plant their gardens because the dust just took over their whole farm. And what I have heard before I had to run down to the other hearing was that we now are suffering the worst drought since 1957. Well, '57 in the geological realm was not really that long but it does show you that we are going to face challenges of drought in a cyclical manner, and if we are going to minimize the damage and loss of wealth to our own people, we have got to have alternatives established.

Now, what I want to ask about is the alternatives right now. Do we still see clouds? Do we—if there—if we have determined that we are in this drought and droughts can last through the cycle, another five years or something, do we see clouds? What about taking water out of the groundwater? Of course, the point that has to be made also, we have to know exactly how much water is in that groundwater before we extract it. And what about massive desalinization by utilization of nuclear power, which we haven't approved one new nuclear power plant in 30 years and perhaps nuclear power could help us desalinate water that would help us get through these cycles.

So I thought I would just throw those questions about the potential of seeing clouds, groundwater, and desalinization as a vehicle to offset these cycles that we are going through. Maybe I will start with my friend from Irvine who I might add I am a proud resident of the county and I overlook—from neighborhood I overlook the University of Irvine right there and we are very proud of what they are accomplishing and what you are contributing to the well being of our country.

Dr. FAMIGLIETTI. Thank you, sir. So I take that to mean you will be watching me from now on.

So just to respond to some of your comments, we do need to look at a range of options in the future because we are going to be water stressed in many regions. And so de-sal is an option, and if we can bring the energy costs down—and maybe it is nuclear, maybe it is something else—we have to—the membrane technology is something that I think is driving up the cost and of course then thinking about what to do with the brines but—and where we live, you know, it is an option. Recycling, of course, we already do in Orange County and we have a phenomenal facility, and if you have never visited, it is right up there on my list with Disneyland.

And so you made a good point about groundwater. I mean it—there is—we can't—many people when we discuss renewable water resources suggest that we just look at sort of the difference between evaporation and precipitation and just use that. And that is a great idea but it doesn't work and that is why we see the groundwater depletion. We just have too many people and we have too many water needs. So—but your point is a good one because we have to know how much water is in the aquifers, not just in the United States but around the world, so we can manage our extractions. And, you know, it is like money in the bank. You don't want to just blow it all at one time.

Mr. ROHRABACHER. Thank you very much.

Thank you, Mr. Chairman, for holding this very significant hearing.

Chairman HALL. Thank you. Good closing.

The Chair now recognizes the gentlelady from California, Ms. Woolsey, for five minutes.

Ms. WOOLSEY. So what does that make me? The cleanup batter, Mr. Chairman, since he is the closer?

Chairman HALL. Depends on whether you walk four in a row or not.

Ms. WOOLSEY. Well, thank you. This has been wonderful because, for one thing, you all seem to be going in the same direction. I don't feel like—and I feel like you are giving us information that isn't based on politics. It is based on science and on observation and that your goals are the same as most of our goals.

I have to say in defense of that little tiny smelt, I represent the 6th Congressional District just north of the Golden Gate Bridge, Marin and Sonoma Counties. And we believe that—and we have a lot of farming but my farmers are college graduates and they are very high-tech, second generation family farmers, ranchers. We know that the smelt has its place in the ecosystem and that, yes, indeed Southern California needs water, but we are not quite willing to, you know, give up protecting what has been there all these

years. So we are—it is going to be a major battle and—but I think we can come up with—work together and come up with the right solutions.

So, okay, my district, new generation of ranchers. They are high-tech. They are—because we have land trusts that keep land in Ag by buying the development rights, these ranches then the new second generation have funds to technically update their barns if they are—for milk, you know, if they are milking cows or their water systems if they are growing grapes. And they know how important what you are doing is. They don't come to me and scream about getting rid of the EPA. I can tell you that. They come to me and they beg me to get these—the Extension Services extended, not cut back. They want the information, what they can do, planned for over the next, they would say, 5 years.

So I—one of my questions to you is in order to relieve the uncertainty which is, you know, I love farmers. Their eyes are so clear because they get it. Most of it depends on Mother Nature. But we are fooling around with Mother Nature as human beings. So this drought monitoring, forecasting, how much of that can, then, come together to talk about prevention? How can we go the next step? And one thing is knowing what is coming. And, you know, let's just start with the first—Dr. Pulwarty and just go down the—

Dr. PULWARTY. Yeah.

Ms. WOOLSEY. —line if you will.

Dr. PULWARTY. Yes, thank you. Now, one of the major things within the NIDIS legislation, the original 2006, was to provide information for being proactive. From that standpoint, it wasn't one post-doc researcher comes in and says, here, let me tell you what happened. But in fact getting closely engaged with how the States, localities, and federal drought and water management plans were being developed to ensure that they could take advantage of the present information.

From our standpoint, having the capabilities and the training with people in those agencies as well as our own on how transfer, communicate, and use information beforehand is a big part of NIDIS.

Ms. WOOLSEY. Thank you.

Mr. BALLARD. I think I should probably defer to the scientific experts.

Ms. WOOLSEY. Okay, thank you, Mayor. I just wanted to give you a chance.

Mr. Strong?

Mr. STRONG. I think I may do that as well.

Ms. WOOLSEY. Okay. Dr. Famiglietti?

Dr. FAMIGLIETTI. Well, it comes down to me. I was writing up my answer. So there is two parts. So you were asking a little bit about the models and the prediction and increasing the—decreasing the uncertainty, and so there is going to be substitute for better models, better data, better observations, better computers. We have to take our observations of water—you know, in a sense we are giving you recommendations just in a simple way based on old technology. And we need to give you—you know, we are a technologically advanced society and, you know, certainly here in the United States, so we could be doing a much better job.

So—but the awareness thing is critical, and so I think the things like—that systems like NIDIS and its partners are essential in getting the message out. I don't know if Dr. Pulwarty, if you have iPad and iPhone apps, but I think it sort of came up in this discussion and it is the kind of thing I think that can really help raise awareness. You know, we take water for granted quite a bit in this country and I think, you know, it is seasons like this, drought season, that are starting to change that.

Ms. WOOLSEY. Right. Ms. Langenfelder?

Ms. LANGENFELDER. Not as a scientist, just as an observer here, I don't know what you would do for prevention but I think awareness, as this gentleman just said, making people aware of water and its importance to their lives and not just assuming it will always be there but to take precautions and preventions and how they utilize water and not waste it, just making people aware. And a drought does that. But then again when it rains, they forgot. So, you know, that is just the issue I think. But scientifically, I have no idea but—about the prevention.

Ms. WOOLSEY. Well, how about the Farmers' Almanac? Is that still useful?

Ms. LANGENFELDER. I think it is a guesstimate.

Ms. WOOLSEY. Thank you, Mr. Chairman.

Chairman HALL. I thank the gentlelady.

And for the people who don't know, this is the last year for Mrs. Woolsey. We are going to miss her. She has been a very good Member of this Committee. She has always acted like she didn't like me but I think deep down she really does. We are going to miss her.

That concludes our questions but I was telling you I was going to give you a practical answer that some of you can give the next time you testify over at the Senate or some other lesser body than this one. It is a practical matter that you can use that I learned the hard way.

I was caught with a hose in my hand on a Friday when the only day you could water was on Wednesday. And I looked over there and a car with black and white lights going off and on and the officer walking toward me with me holding that hose. It turned out that a lady who had just moved into our neighborhood saw me with the hose—I guess she must have been a Democrat—but she called the city and told them that Congressman Hall was out there watering; this was not a watering day. And he had to come.

So he walked up to me, said, Congressman Hall, I hate to do it but I have to give you a ticket. I said, no, I am not going to get a ticket. He said, sir, you are not different than anybody else. I said, yes, I am different. I am a little bit different in this situation. He said, well, it disappoints me to hear you say something like that. My dad is one of your campaign managers and he is going to kill me, but I got to give you a ticket. And I said, no, take this hose. He said I am not going to touch that hose. I took his hand and made him take the hose. I said, now, start walking. We walked about 25 yards back up to where I have a 20,000 gallon tank and curb-and-gutter, I catch that water off my own roof and have a 600-gallon tank from a swimming pool, catch it from the other end of the house. That is the practical way to use the water that falls and

not let it go on down to the gutter. He said, whew, I am glad. I was, too.

But there you have a way. Tell people to curb-and-gutter their houses and save that water that God gives us and use what he gives us. And something to give you a good practical use, Mayor, take that one home with you.

Thank you all very much and—the witnesses for your very valuable testimony. And if Members of this Committee have additional questions for any of you, they will respond—they will ask you to—in writing to give us—and hope you will give us a response to that. The record will remain open for two weeks for additional comments.

And with that, if I can find my gavel, we thank you once again very much. We are adjourned.

[Whereupon, at 11:52 a.m., the Committee was adjourned.]

Appendix I

ANSWERS TO POST-HEARING QUESTIONS

ANSWERS TO POST-HEARING QUESTIONS

Responses by Dr. Roger S. Pulwarty

**U.S. HOUSE OF REPRESENTATIVES
COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY**

**Hearing Questions for the Record
The Honorable Ralph Hall**

Drought Forecasting, Monitoring, and Decision-Making: A Review of the National Integrated Drought Information System

Dr. Roger S. Pulwarty

1. In the testimony given by Mr. Strong on the draft legislation, he specifically recommends that the report required of the National Integrated Drought Information System (NIDIS) program include identification of those objectives still lacking full implementation. What components of NIDIS still lack full implementation, and what stands in the way of these goals being realized?

Response:

The NIDIS program was designed to meet the following objectives:

- Develop the leadership and networks to implement an integrated drought monitoring and forecasting system at Federal, state, and local levels;
- Foster and support a research environment focusing on risk assessment, forecasting, and management;
- Create an "early warning system" for drought to provide accurate, timely, and integrated information;
- Develop interactive systems, such as the Web Portal, as part of the early warning system; and
- Provide a framework for public awareness and education about droughts.

In order to directly meet those objectives, a NIDIS Implementation Plan was developed, including specific milestones. Many of the milestones set forth in the NIDIS Implementation Plan have been completed. Others are currently in progress. A full list of milestones can be found in the NIDIS Implementation plan found at this weblink:

<http://www.drought.gov/pdf/NIDIS-IPFinal-June07.pdf>. Efforts underway that continue to be strengthened include: drought forecast regionalization (improving seasonal yearly forecasts at the regional scale), inventories and coordination of drought-related services and research, and transfer of tools and approaches to other regions.

As noted in the testimony, however, there are several advances that could be made to achieve the goal of a truly national drought early warning system intended by the NIDIS Act. These include improvements in our understanding of drought variability and forecast reliability from intraseasonal to interannual and longer time scales; improved communication with the planning and preparedness community to enhance the use and the value of our existing forecast systems and observing networks; developing a dialogue among the states to share best practices for integrating monitoring and forecast information into drought planning;

enhancing drought impact reporting and increasing our understanding of the relationship between drought indicators/indices and drought impacts; the transfer of successful approaches to other regions across the U.S. that do not yet have active early warning systems.

A critical piece to implementing the improvements above, and NIDIS in general, is establishing effective partnerships with states, tribes, and local governments. This allows the information generated from NIDIS and its partners to find the most effective points of entry and also ensures the information is delivered in a useful and useable format. NIDIS has made progress in this area already in several regions and it will continue to be essential as NIDIS develops early warning systems across the U.S.

2. In your testimony you explained that the NIDIS program office oversees the multi-agency and multi-state NIDIS Program Implementation Team.
 - a. Who serves on this team and how were members of the team chosen?

Response:

The NIDIS Program Implementation Team (NPIT) members include individuals throughout the agencies responsible for all aspects of NIDIS implementation. The NPIT team members were chosen to represent a broad diversity of interest from Federal, state, tribal, academic, and private institutions. A series of workshops were held with Federal, state, private, and tribal drought-sensitive (e.g. water, agriculture) agencies after the NIDIS act was created. These workshops engaged relevant experts in each NIDIS component (monitoring/forecasting, impacts assessment, drought portal, communication etc.). Individuals were identified based on their experience, sector or area of focus, and geographic region. These experts then populated the NPIT based on their ability to contribute expertise and act as a link to their respective agency or community in early warning pilot regions. They are:

- Deborah Bathke, National Drought Mitigation Center
- Michael Brewer, NOAA/ National Environmental Satellite, Data, and Information Service (NESDIS)/ National Climatic Data Center
- Mark Brusberg, U.S. Department of Agriculture (USDA)/Office of the Chief Economist
- Art Degaetano, Northeast Regional Climate Center
- Nolan Doesken, Colorado Climate Center (Colorado State University)
- Eric Evenson, U.S. Geological Survey (USGS) Water Census lead
- Gary Collins, Indigenous Water Network
- Michael Hayes, National Drought Mitigation Center
- Charles Hennig, U.S. Bureau of Reclamation
- Wayne Higgins, NOAA/National Weather Service/Climate Prediction Center
- Steve Hilberg, Midwestern Regional Climate Center
- Margaret Hiza Redsteer, USGS
- Doug Kluck, NOAA/NESDIS/National Climatic Data Center
- Thomas Iseman, Western Governors' Association

- Annarita Marrioti, NOAA/Office of Oceanic and Atmospheric Research (OAR)/Climate Program Office
- Hope Mizzell, South Carolina State Climatology Office
- Phil Mote, Oregon State University
- Rolf Olsen, U.S. Army Corps of Engineers
- Phillip Pasteris, CH2M Hill, Inc.
- Roger Pulwarty, Chair, NOAA/OAR/Climate Program Office
- Kelly Redmond, Western Regional Climate Center
- David Robinson, Rutgers University
- Siegfried Schubert, National Aeronautics and Space Administration (NASA)
- Mark Shafer, University of Oklahoma
- Anne Steinemann, University of Washington
- Jean Steiner, USDA/Agricultural Research Service
- Michael Strobel USDA/Natural Resources Conservation Service
- Mark Svoboda, National Drought Mitigation Center
- Dennis Todey, South Dakota State University
- James Verdin, U.S. Geological Survey
- Robert Webb, NOAA/OAR/Earth System Research Laboratory

b. Are the members dispersed throughout the country?

Response:

Yes. The NPIT members are dispersed throughout the country.

c. Is the team responsible for the implementation plans and associated milestones?

Response:

NPIT members are responsible for coordinating the implementation of NIDIS. NOAA is responsible for reporting on those milestones. The NPIT relies heavily on collaborations with many other drought and climate professionals from various Federal, state, county, tribal, and academic institutions across the country.

d. If all the milestones are reached, what will the function of the program implementation team be?

Response:

The NPIT, and the organizations represented, are critical elements for building and sustaining the NIDIS effort. Once all of the NIDIS milestones have been reached, NPIT members will continue to contribute their expertise to NIDIS drought early warning and information systems, as needed and as drought events (such as the major event of 2012) develop. While the name of the advisory group and the composition will likely change over time, the essential function of the NPIT will remain even after implementation. We anticipate the Drought Early Warning Systems (DEWS) will evolve over time to include more local data and improved forecasts, and aspects of the DEWS will be updated as drought conditions and information needs across the country change and as we

understand more about drought and decadal-scale climate such as from the Pacific Decadal Oscillation and the Atlantic Multidecadal Oscillation.

3. You identified areas in which NIDIS needs to continue improving in order to achieve a truly national drought information system. You identified the role of precipitation events (i.e. “drought busters”) in ending droughts as a subject that requires further understanding. Can you elaborate a bit more on what you mean by this, and what would be gained by an understanding of these types of precipitation events? How could this information be utilized by drought planners and water managers?

Response:

There are several meteorological phenomena that could be classified as “drought busters.” Single major events or a large number of smaller events can contribute to reducing drought impacts and ending drought conditions. These phenomena may bring much-needed precipitation to areas that have been in drought and are a key information component that has been requested by many stakeholders since NIDIS started.

These phenomena include:

- **Atmospheric Rivers** – Concentrated “ribbons” of moisture transported from the ocean to the continent. As these concentrated streams of moisture impinge upon the continent, significant rainfall can occur in a small geographic area over a short period of time, especially if there is elevated terrain as on the west coast of the U.S.
- **Rain associated with monsoonal flow** – When the North American Monsoon begins in summer, increased amounts of precipitation may fall in Arizona, New Mexico, and Colorado.
- **Slow-moving Mesoscale Convective Complexes** – These large systems of thunderstorms, lasting for several hours, typically overnight, can bring large amounts of precipitation to the central U.S. The precipitation associated with these systems increase soil moisture, enhancing the chances of the future formation of thunderstorms.
- **Tropical Storms and Hurricanes** – Tropical storm Debby, which hit the panhandle of Florida earlier this summer, brought 20 inches of rain to parts of northern Florida, ending the severe drought in this area.

NOAA scientists and research partners in academia and other agencies are continually working together to understand the dynamics of these types of systems (e.g., how changes in wind, temperature, and moisture with height above the earth’s surface affect the development and strength of these phenomena). How these events contribute to ending drought, and how improvements in their forecasts can be incorporated into early warning systems is one of the next steps for NIDIS. In addition to understanding the inner-workings of these systems, it is important to understand the larger-scale environment, such as the phases of the El Niño – Southern Oscillation (ENSO), in which these systems are embedded. The state of the ENSO affects the timing and intensity of all of these phenomena.

Increased understanding of both the dynamics and the climatology of these events, through research, will improve prediction of the timing, intensity and the location of these events. In

turn we could inform water managers and drought planners to prepare for these drought busters, as well as the possibility of flooding. For example, farmers could make better decisions about when and what to plant, and reservoir operators could make better decisions about releasing water versus holding it in storage.

4. Please explain how the regional drought early warning system pilot projects work and where they are located. What is the utility of these pilot projects to states and localities for drought forecasting? Are there plans to expand the early warning system? Where is NIDIS currently developing or planning to develop regional drought early warning systems?

Response:

Through long-term partnership building and carefully planned stakeholder meetings to assess regional needs, Regional Drought Early Warning Information Systems (RDEWS) have been established in the Upper Colorado River and the Apalachicola-Chattahoochee-Flint (ACF) River Basins. RDEWS are built following the general stepwise process below:

1. Understand the River Basin Basics - both the physical system and information needs
2. Assess RDEWS Needs through Stakeholder Meetings
3. Establish the Blueprint for an RDEWS through additional Stakeholder Meetings
4. Start the RDEWS Activities - identify individuals and networks to carry out work, refine activities as lessons are learned, evaluate progress
5. Continuation of the DEWS Beyond the Pilot – refine activities, identify a “home” for longer term support

There are many benefits of RDEWS pilot projects to stakeholders including states and localities. Table 1 summarizes the activities that were established for the Upper Colorado River Basin pilot and examples of the benefits and utility of these pilot projects. These activities were developed after stakeholder meetings, subject matter workshops, and stakeholder interviews, and are conducted in partnership with the actual users of drought forecasts and information.

Table 1: Pilot activities, partnerships and benefits of the Upper Colorado River Basin Drought Early Warning and Information System.

Upper Colorado River Basin		
Outcome	Partnerships	Benefits/Utility
Drought Assessment Webinars (held weekly or	Colorado State University, U.S. Geological Survey, National Weather Service (Weather Forecast Offices in Boulder, Pueblo, Grand Junction and the Colorado Basin River Forecast Center), United	Drought and water supply information targeted for a wide range of stakeholders presented in a streamlined manner; Opportunity for local experts to interact with the drought monitor author regarding potential

monthly depending on the season)	States Drought Monitor (USDM) authors, USDA Farm Service Agency, Colorado Water Conservation Board (CWCB), Denver Water, Colorado River District, Bureau of Land Management (BLM), Northern Colorado Water Conservancy District, ski areas, Wyoming State Climatologist, NOAA Regional Climate Centers, Bureau of Reclamation, USDA Natural Resources Conservation Service (NRCS), USDA Office of the Chief Economist	changes to the USDM map; The resulting increased confidence in the USDM led to its formal recognition as an indicator to trigger action under the revised Colorado Drought Plan; Summaries of the webinars are emailed to stakeholders; Transferability: When drought in southeast Colorado (part of the broader Southern Plains drought) became severe in 2011, the webinar organizers adapted to the current conditions and provided the needed information for stakeholders even though this region was outside of the pilot area
Updated Surface Water Supply Index (SWSI)	NRCS, CWCB, State Engineer	In response to user demand, NRCS upgraded its Colorado Surface Water Supply Index (SWSI) implementation to a more statistically robust index calculation and increased the spatial resolution from Hydrologic Unit Code (HUC) 4 to HUC 8
Water Demand Spatial Analysis	National Center for Atmospheric Research (NCAR)	This project aims to fill gaps in knowledge about the variations in water demand patterns in the Upper Colorado River Basin (UCRB) in response to climate variability. This includes documentation of the effects of the administration of water rights during periods of shortage as well as existing adaptive practices such as transfers and exchanges of water rights. The information will identify potential vulnerabilities in water management during severe or sustained droughts. The identified relationships between drought indices and the extent of junior water right diversion curtailments provide the potential for more targeted drought preparedness and early warning.
Stakeholder Interviews	Colorado State University (CSU)	The Colorado state climatologist interviewed water managers in the northernmost region of the UCRB to ascertain their needs and concerns during times of drought. The findings from these interviews and focus groups provided the basis for the Drought Assessment Webinar series, and motivated engagement of USDM authors to improve the national product's representation of the UCRB. This is because the interviews showed that previously the USDM was consulted to see conditions in neighboring states, but wasn't trusted 'at home.'
Pilot Web Page	NOAA/NIDIS	A web page was developed to provide links to weather, climate and water web sites, as well as post meeting information, news articles,

		stakeholder agencies and Drought Assessment Webinar information
Water Supply Webinars and Web Site	NWS CBRFC	Monthly webinars (in season) reviewing state of global climate system (ENSO, etc); seasonal precipitation, temperature, and snow pack and latest forecasts for UCRB seasonal cumulative inflows to major reservoirs in the system. A web site was established to maintain and present the observations and model results covered by the webinars.
Analysis of the UCRB Stream Gaging Network	USGS Utah Water Science Center	The study assessed how well the watersheds instrumented with USGS stream gages represent the varied landscapes in all UCRB watersheds, to identify gaps in monitoring. Results of this study can be found in the USGS Scientific Investigations Report 2011-5081, "Analysis of Watersheds Monitored by the U.S. Geological Survey Streamflow-gaging Station Network in the Upper Colorado River Basin", By Terry A. Kenney, Susan G. Buto, and David D. Susong.

There are plans underway to expand the system and develop additional RDEWS for California (Central Valley, Klamath River Basin, Russian River Basin and Southern California), Four Corners Tribal Lands, North and South Carolina Coastal Ecosystem Regions, the Chesapeake Bay, Rio Grande/Rio Bravo, and the Missouri Basin.

5. The drought monitor provides a pictorial representation of which parts of the country are in drought, and also indicates the level of severity of the drought conditions.
 - a. Can you explain the ranking system used to classify drought (D-1 through D-4), and elaborate on what characteristics are examined to make these designations?

Response:

The ranking system used by the U.S. Drought Monitor is considered a composite indicator; it groups of combines various indices into a single index. The idea is to use the strengths of a variety of inputs, yet maintain a single, simple source of information for decision and policy makers or the public. The indices used and the ranges corresponding to each drought severity category can be seen in the table below. The indices used include the Palmer Drought Index, the NOAA Climate Prediction Center (CPC) Moisture Model, USGS Weekly Streamflow, the Standardized Precipitation Index, and Objective Short and Long-term Drought Indicator Blends. The table can also be found on the drought monitor web site (<http://droughtmonitor.unl.edu/classify.htm>). The Drought Monitor is developed by the USDA, NOAA and the University of Nebraska (National Drought Mitigation Center). NIDIS provides support through NOAA and to the NDMC.

A classification scheme was chosen that was familiar with the hazard community and the general public such as the Saffir-Simpson Hurricane Wind Scale. The classification system is based on the utilization of a ranking percentile approach. This approach gives historical context to any index value in that it shows the percentage of values in its frequency distribution and thus allows comparison of multiple indices. The classification categories run from D0-D4, where D0 is equal to “abnormally dry” (30th percentile) conditions and is not a drought category but signifies the potential for drought; D1 is considered “moderate drought” (20th percentile); D2 is “severe drought” (10th percentile); D3 is “extreme drought” (5th percentile); and D4 is considered “exceptional drought” (2nd percentile).

- b. Are the levels uniform across all parts of the country? For example, are the conditions associated with a moderate drought in Texas the same as for a moderate drought in Maryland?

Response:

Even though the same criteria, as listed in Table 2, would be used to classify a drought as moderate in Texas or in Maryland, the differences in the impacts felt by residents in each state could be very different. The USDM uses a percentile approach in determining the thresholds for each category (D0-D4). All data used in determining a drought category are considered with reference to their historical frequency of occurrence for the location and time of year in question. These objective inputs are then assessed against local impacts and vulnerability and adjusted accordingly.

Table 2: Drought Severity Classification

		Ranges					
Category	Description	Possible Impacts	Palmer Drought Index	CPC Soil Moisture Model (Percentiles)	USGS Weekly Streamflow (Percentiles)	Standardized Precipitation Index (SPI)	Objective Short and Long-term Drought Indicator Blends (Percentiles)
D0	Abnormally Dry	Going into drought: short-term dryness slowing planting, growth of crops or pastures. Coming out of drought: some lingering water deficits; pastures or crops not fully recovered	-1.0 to -1.9	21-30	21-30	-0.5 to -0.7	21-30
D1	Moderate Drought	Some damage to crops, pastures; streams, reservoirs, or wells low, some water shortages developing or imminent; voluntary water-use restrictions requested	-2.0 to -2.9	11-20	11-20	-0.8 to -1.2	11-20
D2	Severe Drought	Crop or pasture losses likely; water shortages common; water restrictions imposed	-3.0 to -3.9	6-10	6-10	-1.3 to -1.5	6-10
D3	Extreme Drought	Major crop/pasture losses; widespread water shortages or restrictions	-4.0 to -4.9	3-5	3-5	-1.6 to -1.9	3-5
D4	Exceptional Drought	Exceptional and widespread crop/pasture losses; shortages of water in reservoirs, streams, and wells creating water emergencies	-5.0 or less	0-2	0-2	-2.0 or less	0-2

6. In your testimony you include a brief synopsis of the history of drought in the U.S. The 2007 Strategic Implementation Plan stressed that there is value in weather and climate observations when they are organized into their historical context.

- a. How long have droughts been occurring in North America?

Response:

Based on the information that we have, droughts have been occurring in North America for many centuries. Paleoclimatic data indicate that droughts in previous centuries have been more intense and lasted longer than the most extreme droughts of the 20th and 21st centuries. For example, the most prolonged and severe drought on the Colorado River lasted approximately 60 years in the mid-12th century. Extreme droughts in the late 16th century affected regions that ranged from northern Mexico and the Intermountain West, to the Mississippi Valley and the southeastern U.S.

- b. How long have records of drought been kept in this country?

Response:

Many quantitative measures of drought have been developed in the U.S., based on the sector and location affected, the particular application, and the degree of understanding of the phenomena. The most prominent index of meteorological drought in the U.S. is the Palmer Drought Severity Index (PDSI). The PDSI was created with the intent of measuring the cumulative departure of moisture supply. The PDSI is a dimensionless number typically ranging between 4 and -4, with negative quantities indicating a shortage of water. The PDSI calculates a series of water balance terms for a generic two-layer soil model, and fluctuations in the hypothetical moisture supply, depending upon observed meteorological conditions, are compared to a reference set of water balance terms. PDSI values are calculated on an ongoing basis by the National Climatic Data Center (NCDC):

<http://www.ncdc.noaa.gov/oa/climate/research/prelim/drought/palmer.html>), and monthly PDSI values have been extended back to 1895.

Using chronologies from tree-ring analysis drought variability for North America has also been quantified using PDSI reconstructions. These estimates can extend back over 2000 years (<http://www.ncdc.noaa.gov/paleo/pdsi.html>).

Assessing drought also requires knowledge of its impacts to identify areas for action and opportunities for using improved information. With support from NIDIS, the National Drought Mitigation Center (NDMC) has developed the first drought impact database in the U.S. The Drought Impact Reporter (DIR: <http://droughtreporter.unl.edu/>) was developed in 2005 and collects impact information on several sectors, including agriculture, public health, energy, fire, and recreation and tourism. Prior to 2005 there was no single assessment or repository of drought impact information.

- c. When did we start systematically measuring and assessing droughts according to a uniform classification system, which allows for comparison of different droughts?

Response:

There are several ways to assess any given drought, and as a result there is no single uniform classification system. Droughts can be defined by their duration, severity, and spatial coverage. They can also be defined by their impacts. There is considerable disagreement over how to classify a drought. For example, the American Meteorological Society classifies drought using four categories: meteorological/climatological, agricultural, hydrological, and socioeconomic, which makes it difficult to assess a drought using a universal drought index. Furthermore, drought characteristics and the wide range of economic sectors on which it has an impact make its effects difficult to quantify. Because of the complexity of drought, no single index has been able to adequately capture the intensity and severity of drought and its potential impacts on such a diverse group of users. As described above, however, the most frequently used index—and longest period of record—of meteorological drought in the U.S. is the Palmer Drought Severity Index (PDSI).

There are typically three approaches to drought assessment: single indicator or index; multiple indicators or indices; or, composite or hybrid indicators. Traditionally, decision makers or researchers employed one indicator or an index due to availability, familiarity, or time constraints. Over the past 20 years, however, there has been increasing global interest and growth in developing several new drought indices based on various indicators. This interest has given decision and policy makers more choices, but there has not always been a clear way of synthesizing them into something simple enough to understand or relay to the public. With the advent of geographic information systems (GIS) and increased computing and display capabilities, the ability to overlay and compare various indicators or indices became prominent.

Over the past decade, a new type of composite indicator has emerged in several forms as a means of merging several indices together. A composite index is a grouping, or combining of various indices into a single index. The idea is to use the strengths of a variety of inputs, yet maintain a single, simple source of information for decision and policy makers or the public. One of the most widely used composite indicators is the U.S. Drought Monitor (USDM; <http://drought.unl.edu/dm>). The USDM integrates multiple data sources and derivative products from local to national scales. The USDM is also unique in that it incorporates feedback and input into the process by maintaining and utilizing an expert user group of approximately 300 people from across the U.S. who serve as a ground truth against the indicators. A convergence of evidence approach is used to combine the indices with impacts and feedback from experts through an iterative process each week. A classification scheme was chosen that was familiar with the hazard community and the general public such as the Saffir-Simpson Hurricane Wind Scale. The classification system is based on the utilization of a ranking percentile approach. This approach gives historical context to any index value in that it shows the percentage of values in its frequency distribution and thus allows comparison of multiple indices. The classification categories run from D0-D4, where D0 is equal to “abnormally dry” (30th percentile) conditions and is not a drought category but signifies the potential for drought; D1 is considered “moderate drought” (20th percentile); D2 is “severe drought”

(10th percentile); D3 is “extreme drought” (5th percentile); and D4 is considered “exceptional drought” (2nd percentile).

The USDM has been produced weekly since 1999 and involves collaboration between the National Drought Mitigation Center at the University of Nebraska, the U.S. Department of Agriculture Joint Agricultural and Weather Facility, and NOAA. The USDM map covers the U.S. including Alaska, Hawaii, and Puerto Rico. The USDM map can be represented in a number of ways. One of the most useful is to look at the percent area of lands classified under drought conditions for the U.S. This can also be done for a specific region or by state and can be calculated from 2000 to present.

Hearing Questions for the Record
The Honorable Eddie Bernice Johnson

1. In your testimony you outline next steps for NIDIS to improve effectiveness of the system. Are there new elements of the program that NIDIS needs Congress to give authority through this next reauthorization? What are the needs of NIDIS to improve the system and federal and state partnerships?

Response:

To achieve the truly national drought early warning presence envisioned by the NIDIS Act requires improvements in our understanding of drought variability and forecast reliability from intraseasonal to interannual and longer time scales. Other specific areas of improvement required would include the following:

- Research to improve numerical weather prediction products, particularly for the seasonal time scale (e.g., 1-month and 3-month temperature and precipitation outlooks),
- Assessment of hydrometeorological monitoring gaps (e.g., stream gages),
- Improvement of our understanding of precipitation events in ending drought,
- Improved collaboration among researchers,
- Improved understanding of how to effectively support natural resource management decisions,
- Improved communication with the planning and preparedness community to enhance the use and the value of our existing observing networks, and
- Enhanced drought impact reporting and increasing our understanding of the relationship between drought indices and drought impacts, and the transfer of successful tools and approaches to regions not yet having active early warning systems.

2. Your testimony mentioned the U.S. Drought Monitor and how great of a partner it is to NIDIS. However you mentioned it is still an unfunded project. Why does this project remain unfunded? And how is the project operating now as a partner to NIDIS without funding?

Response:

The USDM has been produced weekly since 1999 and involves collaboration between the National Drought Mitigation Center (NDMC) at the University of Nebraska, the U.S. Department of Agriculture, and NOAA. The USDM map covers the U.S. including Alaska,

Hawaii, and Puerto Rico. The USDM is an important tool, utilized by the USDA, the Internal Revenue Service policy makers, the media, and the public.

Even though the USDM does not receive direct line item support, it is funded and produced through in-kind contributions from 11 rotating USDM authors from NOAA, USDA, and NDMC (one author per week and a new author rotates every two weeks). The USDM also incorporates feedback and input into the process by maintaining and utilizing an expert user group of approximately 300 people from across the U.S. who serve as a ground truth against the indicators. The NDMC (University of Nebraska) works closely with NIDIS and is the key non-Federal partner in producing the drought monitor.

Hearing Questions for the Record
The Honorable Paul Broun

1. I am sure you are aware of the negative impact the current drought in Georgia is having on reservoir levels, including Lake Hartwell in my district, which is managed by the U.S. Army Corps of Engineers. There have been instances in which water has been allowed to pass through this reservoir while the surrounding communities suffer from drought.
 - a. Does the NIDIS program have any interaction, or provide information to the Corps on drought management, drought conditions, or related issues with regard to the management of this reservoir?

Response:

A key partner for NIDIS in the Apalachicola-Chattahoochee-Flint (ACF) River Basin is the U.S. Army Corps of Engineers (USACE) Mobile District. NIDIS has partnered with the USACE to discuss and communicate the current status of drought in the basin and the potential for conditions to deteriorate or improve. This has been accomplished in the ACF through an ACF Basin monitoring group that includes other participants such as the state climatologists from Georgia, Florida, and Alabama, the U.S. Geological Survey, Georgia Environmental Protection Division, local governments such as Cobb, Griffin, Gwinnett, and Habersham counties, stakeholder groups such as the ACF Stakeholders, and the Southeast Climate Consortium (the consortium includes the University of Georgia, University of Florida, Florida State University, and Auburn University among others).

This group has been providing drought information to stakeholders on a bi-weekly basis through a drought assessment webinar series that is organized by the Southeast Climate Consortium. The USACE regularly participates in these webinars with updates about current and forecast lake levels and their drought operations. The USACE engineer is also available for the question and answer period at the end of the webinar. Engineers from the Mobile District have also been active participants in the pilot by attending stakeholder meetings, presenting information about how they operate the dams in the ACF basin, and answering questions from stakeholders.

Through these interactions we have learned that the USACE has to plan for competing water needs in the basin and has to follow minimum flow release guidelines to protect

endangered species. There are additional minimum flow targets to maintain the quality of drinking water and also for maintaining fishery and shellfish resources in the Apalachicola Bay at critical times of the year.

- b. Are there ways in which NIDIS can improve or better-inform the decision-making process employed by water managers in terms of reducing or stemming outflows or releases from reservoirs during a drought?

Response:

NIDIS' approach has been to develop regional drought early warning information systems (RDEWS) by convening the major information providers; identifying the best mechanisms to develop and communicate information; and by ensuring that Federal, state and local drought and water resources planning and implementation can take advantage of the cross-agency information coordinated by NIDIS at the right time for decision-making. As NIDIS expands the number of RDEWS across the U.S. we will use what has been accomplished in the Upper Colorado Basin, California and the Mobile District in the ACF as a model to partner with the USACE and other Federal, State and Tribal agencies in other basins.

Responses by The Honorable Gregory A. Ballard

OFFICE OF GREGORY A. BALLARD, MAYOR OF INDIANAPOLIS
 QUESTIONS FOR THE RECORD REGARDING TESTIMONY BEFORE THE JULY 25, 2012
 U.S. HOUSE OF REPRESENTATIVES COMMITTEE ON SCIENCE, SPACE AND TECHNOLOGY
 AUGUST 30, 2012



- 1. FROM YOUR TESTIMONY IT APPEARS THE US DROUGHT MONITOR, WEEKLY DROUGHT UPDATES AND RELATED PRODUCTS MAINTAINED ON THE NIDIS DROUGHT PORTAL, ARE UTILIZED FOR MULTIPLE PURPOSES, FROM PLANNING TO COMMUNICATION. ABSENT THIS INFORMATION BEING READILY AVAILABLE, HOW WOULD YOUR CITY PROCURE RELIABLE, TIMELY, AND FREQUENTLY UPDATED INFORMATION?**

Without NIDIS, it would be a difficult task to track reliable and timely information. The City of Indianapolis would primarily rely on partners with the State of Indiana and the National Weather Service. However, both of these partners accumulate information and compile data from multiple counties, requiring Indianapolis to place more resources towards disaggregating the data and making it meaningful to local authorities.

The local utility Citizens Water would depend on local weather forecasts and stream data gathered by the local office of the National Oceanic and Atmospheric Administration.

With NIDIS, all the information is gathered and provided to our city officials and local utilities in a readable and visual format. The way the information is presented provides for quality decision-making, allowing us to protect the public and maintains our resources during drought conditions.

- 2. YOU HAVE HAD TO TAKE STEPS TO CURB WATER USAGE DUE TO THE CURRENT DROUGHT SITUATION. CAN YOU EXPLAIN THE DECISION-MAKING PROCESS YOUR OFFICE UNDERTOOK WHEN CONTEMPLATING RESTRICTIONS, BANS, CURTAILMENTS, AND OTHER DROUGHT-RELATED MEASURES? WHAT SORT OF INFORMATION DID YOU TAKE INTO ACCOUNT WHEN MAKING THE DECISIONS YOU MENTIONED IN YOUR TESTIMONY, SUCH AS ISSUING A DISASTER EMERGENCY DECLARATION AND A FIREWORKS BAN?**

Citizens Water uses Drought Management Guidelines that correspond to the City of Indianapolis Water Conservation Ordinance. The guidelines have tiers that trigger various voluntary and mandatory conservation steps based on factors including rainfall, water usage and reservoir and stream levels.

A water warning is defined in Code: "Water warning means an occurrence wherein mandatory conservation measures are appropriate due to the levels in either of the reservoirs having been reduced to less than their designed drawdown curves or less than an estimated 50% of their annual drawdown design capacities, groundwater wells not functioning properly due to reduced groundwater levels, or the existence of other circumstances that have reduced the amount of treated water available to customers, as determined by Citizens Energy Group."

The procedure begins when Citizens Water notifies the Mayor's Office when water levels reach certain thresholds. The Mayor of Indianapolis makes the decision regarding what restrictions,

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bans, or use curtailments are necessary based on discussions with Citizens Water and the Indianapolis Department of Homeland Security, and then issues an Executive Order.

Due in large part to the information and tools provided through the NIDIS website, it was very clear that a much stricter ban and/or restriction should be put in place for the City of Indianapolis and its residents. The burn ban and the fireworks ban were also handled as executive orders.

3. IN YOUR TESTIMONY, YOU MENTIONED THE LOCAL WATER UTILITY AND COMMENTED ON THE ROLE THEY HAVE PLAYED IN WATER MANAGEMENT AND MEASURES THEY HAVE TAKEN TO CURB WATER USAGE.

a. CAN YOU EXPLAIN THE INTERACTION BETWEEN YOUR OFFICE AND THE LOCAL UTILITIES, INCLUDING THE TYPE OF INFORMATION SHARED AND HOW THE UTILITY COMMUNICATES THE CITY'S WATER SUPPLY SITUATION TO YOUR OFFICE?

The local utilities work and train with the Division of Homeland Security to stay on top of emerging situations or crises as related to drought or water shortage.

Throughout the drought Citizens Water has provided a daily email update to the Mayor's Office, the Department of Code Enforcement, city and town officials in the 8-county area, and to other utility stakeholders. This update includes water usage, reservoir levels and distribution system issues.

During the first few weeks of the mandatory water restrictions imposed July 13th, Citizens Water held a weekly conference call with the city and other stakeholders. Other daily communication also occurred as questions arose about enforcement of the restrictions.

Citizens Water provided daily email updates regarding rainfall, water levels and usage. From the information provided by Citizens Water, there was a tremendous drop in usage after Indianapolis moved from voluntary to mandatory restrictions.

b. CAN YOU EXPLAIN THE PROGRESSION FROM THE VOLUNTARY RESTRICTIONS ISSUED BY THE UTILITY TO THE MANDATORY RESTRICTIONS PUT IN PLACE BY YOUR OFFICE?

The progression from voluntary to mandatory restrictions was triggered by the following:

- Water withdrawals at Morse and Geist reservoirs exceeded the level that would allow for seasonal recharging.

OFFICE OF GREGORY A. BALLARD, MAYOR OF INDIANAPOLIS
 QUESTIONS FOR THE RECORD REGARDING TESTIMONY BEFORE THE JULY 25, 2012
 U.S. HOUSE OF REPRESENTATIVES COMMITTEE ON SCIENCE, SPACE AND TECHNOLOGY
 AUGUST 30, 2012



- Groundwater levels in some water production fields reached critically low operating levels.
- Declaration of an "extreme" drought for Central Indiana by the Indiana Drought Monitor

Notably, the local utility cannot issue a water warning of its own accord. It must request that the Mayor issue a water warning, which is then handled by executive order. Again, these restrictions are governed by ordinance. If necessary, the City could also issue a water ban, which would be even more stringent than the water warning.

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Responses by Mr. J.D. Strong
 U.S. HOUSE OF REPRESENTATIVES
 COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY

Drought Forecasting, Monitoring and Decision-making: A Review of the National Integrated Drought Information System

Response to Testimony

J.D. Strong, Executive Director
Oklahoma Water Resources Board

Hearing Questions for the Record **The Honorable Ralph Hall, Chairman**

1. *In your testimony you state that prior to NIDIS, there was no federal program in place to coordinate drought research among federal agencies, and that traditionally, stakeholder involvement has not been a focus of federal research programs.*
 - a. *Can you explain how NIDIS has changed this?*

Historically, there has been little coordination among federal agencies with respect to drought-related science programs. However, NIDIS has improved this coordination, especially in observational and research activities. Through its "Coping with Drought" initiative, NIDIS adds research funding to existing agency programs to stimulate competitive research projects aligned with national priorities. As a result, NIDIS has not had to create its own, separate research infrastructure. Its needs are met through adding additional drought-related research priorities to existing agency calls for proposals.

NIDIS is closely aligned with several NOAA programs, including the Regional Integrated Sciences and Assessments (RISA) teams and the Sectoral Applications Research Program (SARP). Both programs already emphasize stakeholder engagement as a part of their research portfolios.

NIDIS also supports stakeholder-driven research through its pilots and funding to the NOAA RISA teams, e.g., the Southern Climate Impacts Planning Program (SCIPP) in Oklahoma. NIDIS currently sponsors four Regional Drought Early Warning System pilots in the Upper Colorado River Basin, Apalachicola-Chattahoochee-Flint River Basin, Four Corners Region and California. In addition, NIDIS provides funding through the NOAA RISA Program to SCIPP, which serves drought warning and management systems in the south central region states of Texas, Oklahoma, Arkansas, Louisiana, Mississippi and Tennessee.

In Oklahoma, SCIPP has been very active in bringing together drought researchers, operational agencies, and practitioners to discuss the evolution, outlook and impacts of drought. SCIPP hosted a workshop on long-term drought planning that included state representatives from each of the six states in our region, along with experts from NIDIS, NOAA and the National Drought Mitigation Center. They co-hosted a series of drought forums to discuss the evolution of drought and prospects for improvement. They also launched a monthly webinar series that focused on sector-specific impacts and management strategies in addressing issues associated

with agriculture, livestock, water resources, wildlife and wildfire, and investigated seasonal forecasting, impacts of La Nina and the Drought Monitor process. These webinars and forums included state and federal agency personnel, water district managers, non-governmental organizations and producer cooperatives presenting on drought evolution and decision-support tools. Several beneficial developments have emerged from these conversations, including creation of an integrated reservoir database.

b. Can you speak to the challenges faced by water planners in dealing with drought before the inception of NIDIS?

Prior to NIDIS, there were basically two types of water management entities -- those who had data and in-house expertise and those that did not. For those with in-house expertise, such as the California Department of Water Resources, NIDIS may not have had much impact on daily operations. However for those that lacked such expertise, particularly smaller water districts, the development of the NIDIS portal has made it much easier to find and apply relevant information. In addition, support of new product development, such as the satellite-based vegetation health and evaporative stress index, has provided new tools to assess impacts of drought that were previously very difficult to identify, even for large water districts.

In the western mountains, water management relies on a complex network of interconnected basins with an ability to make interbasin adjustments on a seasonal or longer time-scale. Much of the available water is pre-determined through snowpack assessments with a well-established program of seasonal stream flow predictions led by the USDA Natural Resources Conservation Service. However, east of the Rockies, such streamflow predictions are largely non-existent, with available water driven more by small spring and summer storm systems than by more predictable snowfall-runoff relationships. These water managers are the primary beneficiaries of NIDIS.

An example is the Lower Colorado River Authority, based in Austin, Texas. Their reservoirs are sufficient to catch and provide water to sustain operations through a single-year or perhaps two-year drought. However, reservoir levels are dependent upon local storm systems that produce heavy rainfall. In 2011 when such storms failed to occur in the headwaters of those basins, reservoir levels dropped to less than half of their capacity. Rains during the fall of 2011, while an improvement over the preceding twelve months, were insufficient to refill those reservoirs. As a result, agricultural water uses downstream were curtailed, devastating the 2012 Texas rice crop and impacting waterfowl migration.

c. How have those challenges been addressed or lessened by the program?

Closely related to the Lower Colorado River Authority example in the previous response, predicting convective storms is an extraordinary challenge for the meteorological community. Until seasonal models are able to reliably make such predictions, management strategies rely more upon good monitoring of short-term rainfall patterns, assessment of soil interactions (e.g., how much rainfall is likely to get absorbed locally versus how much runs off into the streams), and general

seasonal outlooks. NIDIS provides relevant information on all three of these facets. However, drought prediction (more technically, intraseasonal to interannual (ISI) climate forecasting) is currently a limiting factor and would be an extremely useful product that NIDIS could provide via coordination of the relevant federal agencies.

2. *In your testimony, you mention a few instances in which the state uses information provided by NOAA to create an additional product, as in the case of the Southern Regional Climate Center's development of an integrated reservoir data base, enabled by the NIDIS seasonal drought outlook. Are there other opportunities for users of NIDIS data to create value-added products tailored to local conditions?*

The example of the integrated reservoir database grew out of the *Managing Drought in the Southern Plains* webinar series hosted by the Southern Climate Impacts Planning Program (SCIPP) RISA team in close collaboration with NIDIS, NOAA and the National Drought Mitigation Center. By providing a forum for water managers from different agencies and different states to talk about water impacts, it was apparent that each relied upon a different set of resources and used different tools to visualize impacts on their water resources. The database is a step toward developing a system that will make it easier for water managers to compare their own reservoir's status with that of their neighbors using a common set of resources and display tools.

Once identified as a priority need by water managers, the Southern Regional Climate Center sought funding from a separate program source within NOAA. The proposal was consistent with NOAA's overall goals and funding for the project was granted. This process can work for myriad topics. For example, a team of researchers led by Oklahoma State University is pursuing funding for a project related to the prediction of wheat yields and qualities—also a need identified in the same webinar series. Producers and researchers began developing the proposal without having a direct connection to NIDIS or NOAA. SCIPP (the webinar series host) worked with them to better understand the funding agency's processes and goals to refine the concept for a full proposal. Thus, any individual or group of researchers with a capability to conduct relevant research or decision-support product development is able to submit proposals for consideration.

3. *In your testimony, you explain that drought is particularly devastating given its nature; it can settle in slowly and often subtly over months or even years. Can you explain some of the more subtle effects of drought that you have dealt with in Oklahoma, and identify any the negative impacts that are not as readily apparent or visible as images of dry creekbeds or withered crops? Additionally, can you speak to some of the long term impacts that you will have to deal with in the aftermath of the current drought?*

The primary impacts associated with drought are crop failures, low streams and lake levels, and wildfires. However, there are a host of secondary (i.e., more subtle) effects. These include impacts on wildlife, tree mortality, changes in noxious weeds and invasive species, water quality, aquifer/groundwater levels, local/regional economies, and human health. In natural habitats, drought affects fields and forests as much as it does planted croplands. Depleted deep soil moisture stresses trees,

either killing them outright or leaving them more susceptible to pests. Younger trees and smaller vegetation are even more vulnerable.

Wildlife patterns change in response to these stresses. Animals either forage in new habitats, coming into contact with humans more often, or concentrate around dwindling water and feed sources, allowing easier predation and spread of diseases. Raccoons, possums, and even larger animals enter the urban fringes as they search for food. In 2007, some deer populations were decimated by the accelerated spread of disease caused by heavier concentrations into smaller areas. Endangered and threatened species, particularly those that cannot migrate, face greater mortality as local food sources diminish and habitat conditions deteriorate.

During the 2011 drought in Oklahoma and Texas, hay was imported from as far away as Manitoba, Canada. Non-native vegetation, including weeds not normally found in our region, may come along for the ride. Despite the best efforts of inspection, invasive weeds and seeds, many better suited to weathering drought conditions, undoubtedly infiltrated this region.

Water quality was also a significant issue in 2011. A proliferation of toxic blue-green algae impacted area lakes as inflow to lakes dried up, water stagnated, and water temperatures soared. These conditions also lead to increasing breeding grounds for mosquitoes carrying the West Nile Virus, as has been witnessed this year.

The economic impact is considerable. When there are fewer crops to harvest, custom harvesters bypass an area, resulting in loss of revenue for hotels, restaurants and stores in rural communities. Equipment that is idled does not need maintenance, affecting local mechanics. Without crops, there is no need to purchase fertilizer and pesticides from local feed stores and applicators.

Human health is one of the often-overlooked impacts of drought, including exposure to toxins and transmitted diseases, concentration of pollutants in diminished water resources, and breathing airborne dust. What is less apparent are the mental stresses placed upon people as their livelihoods are disrupted. Ranchers who have to sell off herds of cattle in which they have invested a lifetime building or farmers unable to make mortgage payments because of no crop revenue are sometimes pushed beyond their breaking point, with increases in alcohol and drug abuse, domestic violence, and suicide resulting.

While the next year may bring an abundant crop, full hotel rooms and restaurants at harvest time, and full reservoirs and aquifers, there are lasting impacts to those who were forced to sell off their farms or herds and face escalating costs as they try to rebuild. Wildlife impacts will linger as some species numbers will take years to recover, if at all. Cattle market recovery can take at least five to ten years as ranchers try to rebuild herds, carefully breeding from genetic stock suitable to the environment with fewer cows available to produce calves. Some changes may take decades to recover, such as soil microbiology impacted by prolonged desiccation.

Hearing Questions for the Record
The Honorable Eddie Bernice Johnson, Ranking Member

1. *In your written remarks and comments on the draft legislation, you urged the Committee to add language explicitly focusing on those NIDIS components still lacking full implementation, particularly the early warning system and drought prediction strategy. What are the needs to ensure full implementation of the early warning system and drought prediction strategy?*

To enable drought prediction, the most immediate requirement is a research program specifically focused on developing regional-scale intraseasonal to interannual ("ISI") forecasting capability, ultimately transitioning that capability to operations. It is important to recognize that NIDIS does not have operational (climate) service responsibilities within NOAA; it is essentially a research prototype laboratory that is currently intended to be a bridge between the research and operational communities. NIDIS is not itself carrying out ISI forecasting research. Research that could inform regional-scale ISI forecasting is being carried out by diverse units/programs within NOAA, including the Geophysical Fluid Dynamics Laboratory (predictability in the climate system, mechanisms that produce predictability), National Centers for Environmental Prediction, and the Climate Program Office's (CPO's) Modeling, Analysis, Prediction, and Projections program (e.g., the National Multi-Model Ensemble seasonal prediction system). Additionally, other modeling efforts being conducted through the CPO extramural grant program and at NOAA's Earth System Research Laboratory could contribute to an operational ISI forecasting program. In short, NOAA has a number of research programs that touch on the subject of regional-scale ISI forecasting, but none that are explicitly designed to develop this forecasting capability and transition it to an operational product. It is also important to recognize that NOAA's CPO is faced with budget reductions of 20 to 30 percent, affecting its ability to move forward with the research to support ISI forecasting.

I respectfully suggest that the Committee solicit NOAA as to how it could establish a research program specifically tasked with developing regional-scale ISI forecasting capabilities. Such a program would support not only NIDIS, but also a range of other programs within the CPO and National Weather Service (NWS), as well as providing a foundation that the private sector meteorology community could use to develop commercial products. Accurate regional-scale ISI forecasting of drought would greatly benefit many sectors of society. Had it been known, for example, that the Midwest U.S. would be faced with severe drought conditions this summer, agricultural producers might have taken steps to reduce their financial exposure.

NIDIS goes beyond seasonal forecasting in its goals to create a system. Forecasting is an important component, but assuring that decision-makers are connected with sources of relevant information is critical. Therefore, it is important that any changes to NIDIS do not undermine its efforts to establish a robust and effective communication system. The pilot projects have shown a tremendous difference in capabilities of groups to access and use available information. These findings need to be harnessed to learn how to develop capabilities in other parts of the nation that

account for local variations in management goals, technical capacity, and information resources without having to develop a pilot in every state or river basin.

2. *You included in your testimony, the Western Governors' Association Policy Resolution entitled "Water Resource Management in the West". In that policy resolution is a subsection for Information Services. Could you explain what other information services need to be developed? And explain further the type of national climate service mentioned in this document.*

As I understand it, the WGA policy statement calls for 'information services' to ensure that data and forecasts are communicated to resource managers and policy makers in a coordinated, effective and relevant way. The policy recognizes that agencies and academics often develop data that is simply stored away rather than being analyzed, shared and applied to make better decisions. As affirmed in its policy, Western Governors see NIDIS as a 'successful model of state-federal collaboration in the development of information services,' thus an example of how a national information service should work. NIDIS coordinates and communicates data in a way that informs decisions.

Federal agencies are considering a more coordinated approach to the development and communication of information relating to general water resource management. The 'Integrated Water Resources Science and Services' (IWRSS) consortium established a goal to "provide the Nation with a seamless suite of consistent water resources monitoring and forecast information – summit to sea." It includes a set of federal agencies with an interest and expertise in water; a plan to engage with state and local resource managers; and the development of a single portal for water resource information. If successful, IWRSS could serve as an effective information service for water.

Similarly, the Governors' policy called for a "national climate service." Conceptually, the idea would be a single venue to coordinate climate information and projections in a way that they could be used by states and other decision-makers in managing climate-sensitive resources and businesses. The Governors have not endorsed any specific proposed model for a national climate service.

One key aspect of effective "information services" is the direct engagement of states and directly connecting science to observations to stakeholders. I am pleased to see that happening with NIDIS and encourage continued state-federal engagement on drought and any future federal "information services."

3. *You mentioned that an early-warning system will be the most worthwhile product of NIDIS. With the current infrastructure in your state, how long does it generally take to disseminate information to the community after the onset of a drought? How does NIDIS assist in getting the information to users? How can NIDIS be improved to make this process more efficient?*

Oklahoma is fortunate to have a population very attentive to weather conditions. The media responds very quickly when the Drought Monitor indicates developing drought conditions. Staff at the Oklahoma Climatological Survey—the state climate office—participate in the weekly discussion of conditions on the Drought Monitor's

discussion list, whether conditions are wet or dry. We also have at our disposal the Oklahoma Mesonet, the most advanced real-time weather observing network of any state in the nation. My agency monitors information coming from the state climate office, media and our own data sources to keep agencies informed of developing conditions, including linking back to the media. Consequently, somebody is always observing and reporting.

While Oklahoma has this great infrastructure, much of it built through its own investment of resources, we still benefit from NIDIS, although timeliness of information dissemination is not the primary issue. The new *Managing Drought in the Southern Plains* webinar series, regional drought forums, long-term planning workshops, and new databases and decision-support tools being developed with SCIPP would not be possible without NIDIS's support. While Oklahoma was already relatively good at early detection of drought, NIDIS makes us even better.

NIDIS is even more essential for states that have not developed as much of an infrastructure. While drought frequently occurs in Oklahoma, it is less frequent in some other parts of the country. Therefore, there is less institutional knowledge that can be called to bear in response. We have seen this in places like Arkansas where drought hit fairly quickly this year and at a severity not seen in decades. The network of experts that NIDIS fosters provides an excellent source of entry to state agencies responding to a developing situation.

Improvement comes with time. It takes time to identify the key people capable of building early-warning networks in each state. It takes time for an event of sufficient magnitude to occur that will garner the attention of state leaders, the media, and others to act. It takes time to build the knowledge of data sources and learn from previous events to prepare for the future. In summary, the best way NIDIS can be improved is to give it more time to continue building upon the excellent foundation of its first six years.

Responses by Dr. James Famiglietti

**U.S. HOUSE OF REPRESENTATIVES
COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY**

**Hearing Questions for the Record
The Honorable Eddie Bernice Johnson**

***Drought Forecasting, Monitoring and Decision-making: A Review of the National
Integrated Drought Information System***

Dr. James Famiglietti

1. Among the goals listed in the NIDIS Implementation Plan is fostering and supporting a research environment that focuses on risk assessment, forecasting, and management. How is NIDIS performing in this area? What changes need to be made?

Responses by Ms. Patricia Langenfelder

1. In your testimony you provided a positive assessment of how NIDIS has helped provide drought-related information and data and improved drought planning. Can you give us an idea of the difficulties that would be presented if the NIDIS program lapsed? Do most farmers have the resources to collect this sort of data or conduct drought assessment and planning absent NIDIS?

The data that is summarized and reported by NIDIS originates from a number of different agencies and departments within the federal government. It would be impractical for any individual to compile the raw data from those original sources. It would be impossible for anyone without advanced technical knowledge and skill to translate that raw data into the kind of clear, simple drought condition summaries that NIDIS produces.

2. You characterized the products NIDIS provides as vital, in part because NIDIS data is available with greater frequency than most other market-related information. Can you explain the importance of having timely and reliable data for agricultural planning and day-to-day operations?

Timeliness of operations is absolutely essential to the success of any type of agricultural enterprise. Failure to make timely decisions in either the production or marketing of agricultural commodities can be costly. For example, failure to start irrigation operations in time could contribute to irreversible crop damage. Failure to appreciate the impact of adverse weather in a key producing region on the commodity market could cause a farmer to miss an important marketing opportunity. By providing ready access to a wide range of timely data on temperature, precipitation, soil moisture and other important weather-related variables, NIDIS provides an indispensable tool to assist farmers with those decisions.

3. You shared with the committee the impact dry pasture conditions are having on ranchers and livestock owners, many of whom are being forced to sell their cattle. You mention that, given the long biological lag time for the livestock production system, the effects of the drought could take some time to reverse. Can you give us any indication of the effect this sell off could have on meat prices, and how long the impact on those prices could last? Are there any past droughts that have impacted meat prices in a significant way?

In the short run, the effect of the drought will be to reduce livestock prices and probably meat prices as well, as forced liquidations lead to more meat on the market – particularly lower-valued processing meats from culled breeding animals. This effect will be short-lived, however. The consequence of reduced production capacity will be smaller meat supplies and higher prices in the future. Short run effects are already being felt as increased cow slaughter is contributing to lower wholesale prices on beef trimmings. By late this year, decreasing supplies could raise prices. How long this lasts will depend on how long this period of high feed prices and diminished forage availability persists and the extent to which higher costs can be passed on to consumers. It will take at least two years before we begin to see any increase in production from herd rebuilding.

Past droughts have certainly squeezed meat production, but generally the effects have been mitigated by what were larger reserves of feedstuffs compared to the current situation.

4. In your testimony you speak to the adverse impacts drought can have on crops and pastureland, and how this will affect the price of corn, feedstock and related agricultural commodities. Can you explain if there are any multiplier effects caused by this pressure on crops and cattle, such as rising costs for products that use or contain corn, cotton, other crops, animal hide or animal fats?

Certainly higher corn prices increase the cost of other products that utilize corn; however, for most consumer items that effect is minimal. Corn and corn-based products are contained in many consumer products, but the contribution that corn makes to the total cost of most of those products is small. Other ingredients, energy costs associated with processing and transportation, labor, packaging, and other marketing functions account for a greater share of total costs, so any multiplier effect of higher corn prices is negligible. For livestock-related products (meat, eggs, dairy, etc.), feed costs are a major component of total costs. Thus, higher corn prices will materially affect prices for those products in the ways previously discussed. Higher corn prices may also affect the prices of commodities that compete with corn for inputs. For example, high corn prices may induce farmers to shift some land from cotton production, eventually leading to higher cotton prices. These effects take a long time – potentially multiple crop years – to develop.